1340

THE

GALLERY

OF

NATURE AND ART;

OR,

TOUR THROUGH CREATION AND SCIENCE.

VOL. II.

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THE

GALLERY

OF

NATURE AND ART;

OR,

A TOUR THROUGH CREATION AND SCIENCE.

BY THE REV. EDWARD POLEHAMPTON,

FELLOW OF KING'S COLLEGE, CAMBRIDGE;

Assisted by Distinguished Writers in the various Departments of the Work.

ILLUSTRATED WITH ONE HUNDRED PLATES,

FROM NEW DESIGNS, DESCRIPTIVE OF THE WONDERS OF NATURE AND ART.

BENEATH HIM, WITH NEW WONDER, NOW HE VIEWS,
IN NARROW ROOM, NATURE'S WHOLE WEALTH.

MILTON.

IN SIX VOLUMES.

VOL. II.

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THE

GALLERY

OF

NATURE AND ART.

PART I.

NATURE.

BOOK II.

GEOLOGY.

[CONTINUED.]

CHAPTER XVIII.

GENERAL HISTORY OF EARTHQUAKES.

WE have already seen that all extensive eruptions of volcanoes, are more or less accompanied with agitations of the circumferent land or water. But we have also various accounts in history of earthquakes that have occurred, without any visible volcano, or in which the volcanic impetus does not appear to have been the chief agency, or the most prominent feature. In like manner subterranean fires, not strictly volcanic, have very generally issued from different fissures of the ground during the returns of the paroxysms: but even this peculiar character has not always been present; and perhaps the most extensive earthquakes have occurred without either of them, and from causes more easily conjectured than accurately ascertained.

Pliny, in the second book of his Natural History, has given an

interesting account of the most celebrated earthquakes of ancient times; many of them, however, accompanied with circumstances of a most marvellous and incredible character.

He also tells us, that the Babylonians ascribed the visitation of earthquakes to the influence of the planets, as affected by the sun about the time of the quadratures; and that various Grecian philosophers, among whom he mentions particularly, Anaximander, and Pherecydes, were capable of prognosticating, and did actually prognosticate, the approach of this tremendous calamity.

He mentions as among the most extended, as well as the most destructive earthquakes, which is spoken of by ancient writers, that by which twelve cities in Asia Minor were swallowed up in one night: he tells us also of another, near the lake Thrasymene, which was not perceived by the armies of the Carthaginians and Romans, that were then engaged near that lake, although it shook the greater part of Italy. And, in another place, he gives the following account of an earthquake of a still more extraordinary kind. "When Lucius Marcus and Sextus Julius were consuls, there appeared a very strange prodigy of the earth, (as I have read in the books of Etruscan Discipline) which happened in the province of Mutina. Two mountains shocked against each other, approaching and retiring with the most dreadful noise. They, at the same time, and in the midst of the day, appeared to cast forth fire and smoke, while a vast number of Roman knights and travellers, from the Emilian way, stood and continued amazed spectators. Several towns were destroyed by this shock; and all the animals that were near them were killed." In the times of Trajan, the city of Antioch, and a great part of the adjacent country, were buried by an earthquake. About three hundred years after, in the times of Justinian, it was once more destroyed, together with forty thousand inhabitants: and, after an interval of sixty years, the same ill-fated city was a third time overturned, with the loss of not less than sixty thousand souls. In 1182, most of the cities of Syria, and of the kingdom of Jerusalem, were destroyed by a like catastrophe. In the year 1594, the Italian historians describe an earthquake at Puteoli, which made the sea retire two hundred yards from its former bed.

History likewise makes mention of an earthquake at Rhodes, more than two hundred years before the christian æra, when that

island was in the height of its commercial consequence. By it, the famous Colossus, of which such incredible things are related*, was thrown down, together with the arsenal, and a great part of the city walls.

In 1638, a dreadful earthquake occurred at Calabria. It is thus described by the celebrated Father Kircher, as it took place while he was on his journey to visit Mount Etna, and who, at the same time notices the rest of the wonders that lie toward the south of Italy.

"Having hired a boat," says he, "in company with four other persons, two friars of the order of St. Francis, and two seculars, we launched on the 24th of March, from the harbour of Messina, in Sicily, and arrived the same day at the promontory of Pelorus. Our destination was for the city of Euphœmia, in Calabria, where we had some business to transact, and where we designed to tarry for some time. However, Providence seemed willing to cross our design; for we were obliged to continue for three days at Pelorus, upon account of the weather; and though we often put out to sea, yet we were as often driven back. At length, however, wearied with the delay, we resolved to prosecute our voyage; and, although the sea seemed more than usually agitated, yet we ventured forward. The gulph of Charybdis, which we approached, seemed whirled round in such a manner, as to form a vast hollow, verging to a point in the centre. Proceeding onward, and turning my eyes to Etna, I saw it cast forth large volumes of smoke, of mountainous sizes, which entirely covered the whole island, and blotted out the very shores from my view. This, together with the dreadful noise, and the sulphureous stench, which was strongly perceived, filled me with apprehensions that some more dreadful calamity was impending. The sea itself seemed to wear a very unusual appearance; those who have seen a lake in a violent shower of rain, covered all over with bubbles, will conceive some idea of its agitations. My surprize was still encreased by the calmness and serenity of the weather; not a breeze, not a cloud, which might be supposed to put all nature thus into motion. I therefore warned my companions that an earthquake was approaching; and, after some time, making for the shore with all possible diligence, we landed at Tropæa,

* See Gallery of Nature and Art, Part II. Book II.

happy and thankful for having escaped the threatening dangers of the sea.

"But our triumphs at land were of short duration; for we had scarcely arrived at the Jesuits College in that city, when our ears were stunned with an horrid sound, resembling that of an infinite number of chariots driven fiercely forward, the wheels rattling, and the thongs cracking. Soon after this, a most dreadful earthquake ensued; so that the whole tract upon which we stood seemed to vibrate, as if we were in the scale of a balance that continued wavering. This motion, however, soon grew more violent; and being no longer able to keep my legs, I was thrown prostrate upon the ground. In the mean time, the universal ruin round me, redoubled my amazement. The crash of falling houses, the tottering of towers, and the groans of the dying, all contributed to raise my terror and despair. On every side of me I beheld nothing but a scene of ruin, and danger threatening wherever I should fly. I commended myself to God, as my last great refuge. At that hour, O how vain was every sublunary happiness! wealth, honour, empire, wisdom, all mere useless sounds, and as empty as the bubbles in the deep. Just standing on the threshold of eternity, nothing but God was my pleasure; and the nearer I approached, I only loved him the more. After some time, however, finding that I had remained unhurt, amidst the general concussion, I resolved to venture for safety, and running as fast as I could, reached the shore, but almost terrified out of my reason. I did not search long here till I found the boat in which I had landed, and my companions also, whose terrors were even greater than mine. Our meeting was not of that kind where every one is desirous of telling his own happy escape; it was all silence, and a gloomy dread of impending terrors.

"Leaving this seat of desolation, we prosecuted our voyage along the coast; and the next day came to Rochetta, where we landed, although the earth still continued in violent agitations. But we were scarce arrived at our inn, when we were once more obliged to return to the boat; and, in about half an hour, we saw the greatest part of the town, and the inn at which we had set up, dashed to the ground, and burying all its inhabitants beneath its ruins.

"In this manner, proceeding onward in our little vessel, finding no safety at land, and yet, from the smallness of our boat, having

but a very dangerous passage at sea, we at length landed at Lopizium, a castle midway between Tropæa and Euphæmia, the city to which, as I said before, we were bound. Here, wherever I turned my eyes, nothing but scenes of ruin and horror appeared; towns and castles levelled to the ground; Stromboli, though at sixty miles distance, belching forth flames in an unusual manner, and with a noise which I could distinctly hear. But my attention was quickly turned from more remote to contiguous danger. The rumbling sound of an approaching earthquake, which we by this time were grown acquainted with, alarmed us for the consequences; it every moment seemed to grow louder, and to approach more near. The place on which we stood now began to shake most dreadfully; so that being unable to stand, my companions and I caught hold of whatever shrub grew next us, and supported ourselves in that manner.

"After some time, this violent paroxysm ceasing, we again stood up, in order to prosecute our voyage to Euphæmia, that lay within sight. In the mean time, while we were preparing for this purpose, I turned my eyes toward the city, but could see only a frightful dark cloud that seemed to rest upon the place. This the more surprized us, as the weather was so very serene. We waited, therefore, till the cloud was passed away: then turning to look for the city, it was totally sunk. Wonderful to tell! nothing but a dismal and putrid lake was seen where it stood. We looked about to find some one that could tell us of its sad catastrophe, but could see none. All was become a melancholy solitude; a scene of hideous desolation. Thus proceeding pensively along, in quest of some human being that could give us some little information, we at length saw a boy sitting by the shore, and appearing stupified with terror. Of him, therefore, we enquired concerning the fate of the city; but he could not be prevailed on to give us an answer. We entreated him with every expression of tenderness and pity to tell us; but his senses were quite wrapped up in the contemplation of the danger he had escaped. We offered him some victuals, but he seemed to loath the sight. We still persisted in our offices of kindness; but he only pointed to the place of the city, like one out of his senses; and then running up into the woods, was never heard of after. Such was the fate of the city of Euphæmia: and as we continued our melancholy course along the shore, the whole coast for the space of two

hundred miles, presented nothing but the remains of cities; and men scattered, without an habitation, over the fields. Proceeding thus along, we at length ended our distressful voyage, by arriving at Naples, after having escaped a thousand dangers both at sea and land."

History describes another severe earthquake of the date of 1693, the most violent effects of which were felt in the island of Sicily, though its motion was perceived in Germany, France, and England. It extended to a circumference of two thousand six hundred leagues; chiefly affecting the sea coasts, and great rivers; more perceivable also upon the mountains than in the valleys. Its motions were so rapid, that those who lay at their length were tossed from side to side, as upon a rolling billow. The walls were dashed from their foundations, and no less than fifty-four cities, with an incredible number of villages, were either destroyed or greatly damaged. The city of Catania, in particular, was utterly overthrown. A traveller who was on his way thither, at the distance of some miles, perceived a black cloud, like night, hanging over the place. The sea, all of a sudden, began to roar; Mount Etna to send forth great spires of flame; and soon after a shock ensued, with a noise as if all the artillery in the world had been at once discharged. One traveller informs us, that being obliged to alight instantly, he felt himself raised a foot from the ground; and turning his eyes to the city, saw with amazement nothing but a thick cloud of dust in the air. The birds flew about astonished; the sun was darkened; the beasts ran howling from the hills; and, although the shock did not continue above three minutes, yet near nineteen thousand of the inhabitants of Sicily perished in the ruins. Catania, to which city the describer was travelling, seemed the principal scene of ruin; its place only was to be found; and not a footstep of its former magnificence was to be seen remaining.

The earthquake of Jamaica, in 1692, was very terrible. The following is one of the best descriptions that have been given of it. "In two minutes time it destroyed the town of Port-Royal, and sunk the houses in a gulph forty fathoms deep. It was attended with an hollow, rumbling noise, like that of thunder; and, in less than a minute, three parts of the houses, and their inhabitants, were all sunk quite under water. While they were thus swallowed up on one side of the street, on the other the houses were thrown into heaps; the sand of the street

rising like the waves of the sea, lifting up those that stood upon it, and immediately overwhelming them in pits. All the wells discharged their waters with the most vehement agitation. The sea felt an equal share of turbulence, and, bursting over its mounds, deluged all that came in its way. The fissures of the earth were, in some places, so great, that one of the streets appeared twice as broad as formerly. In many places, however, it opened and closed again, and continued this agitation for some time. Of these openings, two or three hundred might be seen at a time; in some whereof the people were swallowed up; in others, the earth closing, caught them by the middle, and thus crushed them instantly to death. Other openings, still more dreadful than the rest, swallowed up whole streets; and others, more formidable, spouted up whole cataracts of water, drowning such as the earthquake had spared. The whole was attended with the most noisome stench; while the thundering of the distant falling mountains, the whole sky overcast with a dusky gloom, and the crash of falling habitations, gave unspeakable horror to the scene. After this dreadful calamity was over, the whole island seemed converted into a scene of desolation; scarce a planter's house was left standing; almost all were swallowed up; houses, people, trees, shared one universal ruin; and in their places appeared great pools of water, which, when dried up by the sun, left only a plain of barren sand, without any vestige of former inhabitants. Most of the rivers, during the earthquake, were stopped up by the falling in of the mountains; and it was not till after some time that they made themselves new channels. The mountains seemed particularly attacked by the force of the shock; and it was supposed that the principal seat of the concussion was amongst them. Those who were saved, got on board ships in the harbour, where many remained above two months; the shocks continuing during that interval with more or less violence every day."

In some parts of South America, earthquakes have been equally tremendous and fatal. It is remarkable, that the city of Lima, the capital of Peru, situated in about 12° south latitude, although scarcely ever visited by tempests, and equally unacquainted with rain as with thunder and lightning, has been singularly exposed to the fury of earthquakes, which happen here so frequently, that the inhabitants are under continual apprehensions of being, from their suddenness and vio-

lence, buried in the ruins of their own houses: yet these earthquakes, though so sudden, have their presages; one of the principal of which is a rumbling noise in the bowels of the earth, about a minute before the shocks are felt, that seems to pervade all the adjacent subterraneous part; this is followed by dismal howlings of the dogs, who seem to presage the approaching danger. The beasts of burden passing the streets stop, and by a natural instinct spread open their legs, the better to secure themselves from falling. On these portents, the terrified inhabitants fly from their houses into the streets with such precipitation, that if it happens in the night, they appear quite naked; the urgency of the danger at once banishing all sense of delicacy or shame. Thus the streets exhibit such odd and singular figures as might afford matter of diversion, were it possible to be diverted in so terrible a moment. This sudden concourse is accompanied with the cries of children waked out of their sleep, blended with the lamentations of the women, whose agonizing prayers to the saints increase the common fear and confusion. The men are also too much affected to refrain from giving vent to their terror; so that the whole city exhibits a dreadful scene of consternation and horror.

The earthquakes that have occurred at the capital of Spanish America are very numerous. The first since the establishment of the Spaniards was in 1582; but the damage was much less considerable than in some of the succeeding. Six years after, Lima was again visited by another earthquake, so dreadful, that it is still solemnly commemorated every year. In 1609, there was a third, which overturned many houses. On the 27th of November, 1630, such prodigious damage was done in the city by an earthquake, that, in acknowledgment of its not having been entirely demolished, a festival on that day is annually celebrated. Twenty-four years afterwards, on the 3d of November, the most stately edifices in the city, and a great number of houses, were destroyed by a similar attack; but the inhabitants retiring, few of them perished. Another dreadful percussion took place in 1678; but one of the most terrible was on the 28th of October, 1687. It began at four in the morning, and destroyed many of the finest public buildings and houses, in which a great number of the inhabitants perished; but this was little more than a prelude to what followed; for two hours afterwards the shock

returned, with such impetuous concussions, that all was laid in ruins, and the inhabitants felt themselves happy in being only spectators of the general devastation by having saved their lives, though with the loss of all their property. During this second shock, the sea retiring considerably, and then returning in mountainous waves, entirely overwhelmed Callao, which is at five miles distance from Lima, and all the adjacent country, together with the miserable inhabitants. From this time six other earthquakes were felt at Lima previous to that of 1746. This last was on the 28th of October, at half an hour after ten at night, when the concussions began with such violence, that, in little more than three minutes, the greatest part, if not all the buildings in the city, were destroyed, burying under their ruins those inhabitants who had not made sufficient haste into the streets and squares, the only places of safety. At length the horrible effects of the first shock ceased; but the tranquillity was of short duration, the concussions swiftly succeeding each other. The fort of Callao also sunk into ruins; but what it suffered from the earthquake in its building was inconsiderable, when compared to the dreadful catastrophe which followed; for the sea, as is usual on such occasions, receding to a considerable distance, returned in mountainous waves, foaming with the violence of the agitation, and suddenly buried Callao and the neighbouring country in its flood. This, however, was not entirely effected by the first swell of the waves; for the sea retiring farther, returned with still greater impetuosity, and covered both the walls and other buildings of the place; so that what even had escaped the first inundation, was totally overwhelmed by those succeeding mountainous waves. Twenty-three ships and vessels, great and small, were then in the harbour, nineteen of which were sunk, and the other four, among which was a frigate named St. Fermin, were carried by the force of the waves to a considerable distance up the country. This terrible inundation and earthquake extended to other parts on the coast, and several towns underwent the same fate as the city of Lima; where the number of persons who perished, within two days after it began, amounted, according to the bodies found, to thirteen hundred, beside the maimed and wounded, many of whom lived only a short time in great torture.

From what is known of the operation of earthquakes, the circumstances generally attending such convulsions of nature appear

to be as follows: 1. A rumbling sound before the percussion; which proceeds from the air, or fire, or both, forcing their way through the chasms of the earth, and endeavouring to get free, which is also heard in volcanoes. 2. A violent agitation or heaving of the sea, sometimes before and sometimes after that at land, which is only a similar effect produced on the waters to that at land, and may be called, for the sake of perspicuity, a sea-quake; and this also is produced by volcanoes. 3. A spouting up of waters to great heights, which it is neither easy to ascribe or account for; though volcanoes are often found to exhibit the same effect, Vesuvius being known frequently to eject a vast body of water. 4. A rocking of the earth to and fro, and some-times a perpendicular rebounding, if it may be so called, of the same. This difference chiefly arises from the situation of the place with respect to the subterraneau fire. Directly under, it rises; at a farther distance, it rocks. 5. Some earthquakes seem to travel onward, and are felt in different countries at different hours the same day. This arises from the great shock being given to the earth at one place, and that being communicated onward by an undulatory motion, successively affects different regions in its progress; as the blow given by a stone falling in a lake is not perceived at the shores till some time after the first concussion. 6. The shock is sometimes instantaneous, like the explosion of gunpowder, and sometimes tremulous, and continuing for several minutes. The nearer the place where the shock is first given, the more instantaneous and simple it appears. At a greater distance, the earth redoubles the first blow, with a sort of vibratory continuation. 7. As waters have generally so great a share in producing earthquakes, it is not to be wondered that they should generally follow those breaches made by the force of fire, and appear in the great chasms which the earthquake has opened.

These are a few of the more striking phænomena of earthquakes, presenting a fearful assemblage of the combined effects of air, earth, fire and water, in a state of unrestrained contention.

[*Pliny*. *Payne's Geog. Extr*. *Estella*. *Phil. Trans*.]

CHAP. XIX.

THE SAME SUBJECT CONTINUED:

From a Collection of various Papers presented to the ROYAL SOCIETY, concerning numerous EARTHQUAKES both in ENGLAND, and other Countries, about the middle of the Eighteenth Century.

ABOUT the year 1750 several earthquakes were felt in many parts of England, indeed almost all over the country: and, though no serious ill consequences attended them, yet they produced a vast number of communications to the Royal Society, stating the circumstances that attended them. These accounts the Society collected, and printed together, at the end of Vol. 46. But, as may be expected, there being a general sameness or uniformity that runs through all such descriptions, as loud rumbling noises, the shaking of the ground, the tottering of houses, the rattling of the windows, and the furniture of houses, &c. which circumstances may be all easily conceived; it would be irksome and disgusting to reprint such a number of tedious, and similar, and uninteresting accounts. Instead of which, therefore, we shall here give a summary of the whole in the following table; containing, in the first column, the date of the earthquakes; in the second, the names of the persons communicating the accounts, with the pages of the original Vol. (46) where the accounts stand; and in the third, the places where the persons write from, or where the earthquake was felt. After which we shall advert to such particular circumstances, that may be more peculiarly deserving of notice.

List of Earthquakes, with the Places and Names of the Writers.

Dates, N. S.	Authors and Pages.	Places.
Feb. 8, 1750	Henry Baker ... p. 601,	London.
....	Gowin Knight...... 603,	......
....	Jo. Freeman....... 605,	....
....	Wm. Fauquier...... 505,	Eltham.
....	Dr. Henry Miles 607,	Tooting.
....	Dr. John Martyn.... 609,	Chelsea.
....	S. Lethicullier...... 613,	Aldersbrose
Mar. 8, 1750	M. Folkes, Esq..... 613,	London.
....	Rev. Tho. Birch.... 615,	....
....	Henry Baker...... 617,	....
....	Dr. H. Miles....... 619,	Tooting.
....	Martin Clare 620,	Kensington.
....	Dr. D. P. Layard . 621,	London.
....	R. Pickering 622,	....
....	J. Burrow, Esq. 626,	....
....	Dr H. Miles....... 628,	Tooting.
....	Dr. J. Martyn...... 630,	Chelsea.
....	Mic. Russel 631,	London.
....	Dr. Ja. Parsons 633,	......
....	James Burrow, Esq. 637,	......
....	Dr. C. Mortimer.... 638,	......
....	Dr. Miles........... 639,	Tooting.
Mar. 18, 1750	J. Ellicott........... 646,	Portsmouth.
....	Daniel Wray, Esq... 647,	....
Mar. 8, 1750	Rev. Dean Cooper.. 647,	Hertford.
Mar. 18, 1750	Rev. Mr. Taylor.... 649,	Portsmouth.
Mar. 19, 1750	Benjamin Cook 651,	Isle of Wight
Mar. 18, 1750	Jos. Colebrooke .. 652,	Southampton
....	P. Newcome 653,	Hackney.
....	Ja. Burrow, Esq. .. 655,	East Sheen.
Mar. 8, 1750	Thomas Burrat...... 681,	Kensington.
Apr. 2, 1750	Robert Paul 683,	Chester.
Mar. 14, 1750	W. Bowman........ 684,	Ea. Molesey
Apr. 2, 1750	Mr. Pennant........ 688,	Flintshire.
Mar. 18. 1750	Nathaniel Downe.... 688,	Bridport.
May 4, 1749	Henry Baker 689,	Winbourn,
July 1, 1747	....	Taunton.
Oct. 1, 1749	M. Reaumur 691,	France.
Feb. 9, 1750	Rev. W. Barlow.... 692,	Plymouth.
Apr. 2, 1750	Rev. J. Seddon...... 696,	Warrington.
Mar. 8, 1750	William Jackson.... 700,	London.
Mar. 24, 1750	M. Mackenzie 701,	Smyrna.
Sep. 30, 1750	William Folkes, Esq. 701,	Newtown.
....	James Burrow, Esq.. 702,	Suffolk.
....	....	Leicester.
....	Sir Thomas Cave.... 706,	- - - - -
....	J. Nixon.......... 707,	Northampton
....	....	Weston.
....	 710,	Warwick
....	Dr. Dodridge...... 712,	Northampton
....	Steward of the Earl of Cardigan - - 721,	Stamford.
....	Henry Green...... 723,	Leicester.
Aug. 23, 1750	M. Johnson 725,	Spalding.
Sep. 30, 1756	Dr. H. Miles 726,	Tooting.
....	William Smith 727,	Peterborough.

It is pretty generally agreed that the shocks lasted only three or four seconds of time. On occasion of these earthquakes, the Rev. Dr. Wm. Stukeley wrote his thoughts on the causes of such phænomena. These are given at three different parts of this Volume of the Phil. Trans.; and were also printed and published by the author, in a separate pamphlet, in 1750, in 8vo. He rejects, he says, the common notion of struggles between subterraneous winds, or fires, vapours, or waters, heaving up the ground like animal convulsions; but he always thought it was an electrical shock; which he is induced to think is the case, from several circumstances which he notices.

"We had lately, says Dr. S., a very pretty discourse read here, from Mr. Franklin, of Philadelphia, concerning thundergusts, lights, and light meteors. He well solves them by the touch of clouds, raised from the sea, which are non-electrics, and of clouds raised from exhalations of the land, which are electrified: that little snap, which we hear, in our electrical experiments, when produced by a thousand miles compass of clouds, and that re-echoed from cloud to cloud, through the extent of the firmament, makes that thunder which affrightens us. From the same principle I infer, says the Doctor, that if a non-electric cloud discharges its contents on any part of the earth, when in a high electrified state, an earthquake must necessarily ensue. As a shock of the electric tube in the human body, so the shock of many miles compass of solid earth, must needs be an earthquake; and that snap, from the contact, be the horrible uncouch noise of it."

Dr. Stephen Hales also, p. 669 of the same Vol. besides noticing the phænomena of the earthquake, ventures on an opinion of the causes of such convulsions. "As to the affairs of earthquakes, says he, particularly that which happened March 8, 1750, about twenty minutes before six in the morning; I being then awake in bed, on a ground-floor, near the church of St. Martin's in the Fields, very sensibly felt the bed heave, and consequently the earth must heave too. There was a hollow, obscure, rushing noise in the house, which ended in a loud explosion up in the air, like that of a small cannon: the whole duration, from the beginning to the end of the earthquake, seemed to be about four seconds of time. The soldiers who were on duty in St. James's park, and others who were then up, saw a blackish

cloud, with considerable lightning, just before the earthquake began; it was also very calm weather.

"In the history of earthquakes it is observed, that they generally begin in calm weather, with a black cloud. And when the air is clear, just before an earthquake, yet there are then often signs of plenty of inflammable sulphureous matter in the air; such as ignes fatui or jack-a-lanterns, and the meteors called falling stars.

"Now I have shewn many years since, continues Dr. Hales, in the appendix to my Statical Essays, the effect that a mixture of a pure and a sulphureous air have on each other; viz. by turning the mouth downwards, into a pan of water, of a glass vessel of a capacity sufficient to hold about two quarts, with a neck about twenty inches long, and two inches wide; then, by putting under it, in a proper glass vessel, with a long narrow neck, a mixture of aqua-fortis, and powdered pyrites, viz. the stone with which vitriol is made, there will be a brisk ferment, which will fill the glass with redish sulphureous fumes; which, by generating more air than they destroy, will cause the water with which the whole neck of the glass vessel was filled, to subside considerably. When the reddish sulphureous air in the upper part of the glass is clear, by standing two or three hours, if then the mouth of the inverted glass be lifted out of the water, so as to let the water in the neck of the glass fall out; which, supposing it be a pint, then an equal quantity of fresh air will rush in at the mouth of the neck of the vessel, which must immediately be immersed in the water: and on the mixture of the fresh air with the then clear sulphureous air, there will instantly arise a violent agitation between the two airs, and they will become, from transparent and clear, a reddish turbid fume, of the colour of those vapours which were seen several evenings before the late earthquakes: during which effervescence, a quantity of air, nearly equal to what fresh air was let in, will be destroyed; which is evident by the rising up of the water in the neck of the glass, almost as high as before. And if, after the effervescence of the mixed airs is over, and become clear again, fresh air be admitted, as before, they will again grow reddish and turbid, and destroy the new admitted air as before; and this after several repeated admissions of fresh air: but after every readmission of fresh air the quantity destroyed will be less and less, till no more will be destroyed. And it is the same after standing several weeks, provided, in the mean time, too much fresh air

had not been admitted. Now, I found the sum total of the fresh air thus destroyed to be nearly equal to the first quantity of sulphureous air in the inverted glass.

"Since we have in this experiment a full proof of the brisk agitation and effervescence which arises from the mixture of fresh air with air that is impregnated with sulphureous vapours, which arise from several mineral substances, especially from the pyrites, which abounds in many parts of the earth; may we not with good reason conclude, that the irksome heat, which we feel in what is called a close sultry temperature of the air, is occasioned by the intestine motion between the air and the sulphureous vapours which are exhaled from the earth? which effervescence ceases, as soon as the vapours are equably and uniformly mixed in the air; as happens also in the effervescences and ferments of other liquors. The common observation therefore, that lightning cools the air, seems to be founded on good reason; that being the utmost and last effort of this effervescence.

"May we not hence also, with good probability conclude, that the first kindling of lightning is effected by the sudden mixture of the pure serene air above the clouds, with the sulphureous vapours, which are sometimes raised in plenty, immediately below the clouds? the most dreadful thunders being usually when the air is very black with clouds, it rarely thundering without clouds; clouds serving, in this case, like the above-mentioned inverted glasses, as a partition between the pure and sulphureous airs; which must, therefore, on their sudden admixture through the interstices of the clouds, make (like the two airs in the glass) a more violent effervescence, than if those airs had, without the intervention of the clouds, more gradually intermixed, by the constant more gradual ascent of the warmer sulphureous vapours from the earth, and descent of the cold serene air from above. And though there was no luminous flash of light in the glass, yet, when such sudden effervescence arises, among a vast quantity of such vapours in the open expanse of air, it may, not improbably, acquire so rapid a velocity, as to kindle the sulphureous vapours, and thereby become luminous.

"And since, from the effects that lightning is observed to have on the lungs of animals, which it often kills, by destroying the air's elasticity in them, as also from its bursting windows outwards, by destroying the air's elasticity on the outside of those windows;

since, I say, it is hence probable, that the sulphureous fumes do destroy a great quantity of elastic air; it should therefore cause great commotions and concussions in the air, when the air rushes into those evacuated places, which it must necessarily do with great velocity

" Dr. Papin has calculated the velocity with which air rushes into an exhausted receiver, when driven by the whole pressure of the atmosphere, to be at the rate of 1305 feet in a second of time; which is at the rate of 889 miles in an hour: which is near eighteen times a greater velocity than that of the strongest storms; which is estimated to be at the rate of fifty miles in an hour.

" Hence, we see that an ourageous hurricane may be caused, by destroying a small proportion of the elasticity of the air of any place in respect to the whole. No wonder then that such violent commotions of the air should produce hurricanes and thunder showers, especially in the warmer climates, where both the sulpureous and watery vapours, being raised much higher, and in greater plenty, cause more violent effects

" M. de Buffon in his Natural History and Theory of the Earth, mentions black dark clouds in the air near the tempestuous Cape of Good Hope, and also in the ocean of Guinea, which are called by the sailor's the Ox's Eye; which are often the forerunners of terrible storms and hurricanes. Whence it is to be suspected, that they are large collections of sulphureous vapours; which, by destroying suddenly a great quantity of the elastic air, cause the ambient air to rush with great violence into that vacuity, thereby producing tempests and hurricanes. And off the coast of Guinea they have sometimes three or four of these hurricanes in a day; the forerunners of which are these black sulphureous clouds, with a serene clear air, and calm sea; which on a sudden turns tempestuous, on the explosion of these sulphureous clouds. And in Jamaica they never have an earthquake when there is a wind to disperse the sulphureous vapours.

" In like manner we find, in the late earthquakes at London, and in the accounts of many other earthquakes, that before they happen there is usually a calm air, with a black sulphureous cloud; which cloud would probably be dispersed like a fog, were there a wind; which dispersion would prevent the earthquake, which is probably caused by the explosive lightning of this sulphureous cloud, being

both nearer the earth than common lightnings, and also at a time when sulphureous vapours are rising from the earth in greater quantity than usual, which is often occasioned by a long series of hot and dry weather. In which combined circumstances, the ascending sulphureous vapours in the earth may probably take fire, and thereby cause an earth-lightning, which is at first kindled at the surface, and not at great depths, as has been thought; and the explosion of this lightning is the immediate cause of an earthquake.

"It is in the like manner that those meteors, called falling stars, are supposed to be kindled into a flame at the upper part of a sulphureous train, which is kindled downwards into a flame, in the same manner as a fresh blown-out candle is instantly lighted from another candle held over it at a distance, in the sulphureous inflammable smoke of it.

"I am sensible that it may seem improbable, that the ascending sulphureous vapours in the earth should thus be kindled; but since they are continually ascending through the pores of the earth, more or less, for many good and useful purposes, it is plain there is room for them to pass. Besides, as Mons. de Buffon remarks, naturalists have observed perpendicular and oblique clifts, in all kinds of layers of earth, not only among rocks, but also among all kinds of earth, that have not been removed, as is observable wherever the earth is open to any depth. Now these clifts are caused by the drying of the several horizontal layers of the earth; and will also be considerably the wider in long dry hot seasons, which are usually the preparatory forerunners of earthquakes, and the explosion of the sulphureous vapours may probably widen them more.

"It is very observable, in the opinion of Borelli and other naturalists, that volcanoes begin first to kindle near the surface or top of the mountains, and not in the caverns in the lower parts of them. Mons. de Buffon says, that earthquakes are most frequent where there are volcanoes, sulphureous matter abounding most there; but that, though the volcanoes continue burning long, yet the earthquakes are not very extensive. But that the other sort of earthquakes, which are not caused by a volcano, extend often to a great distance. These are much longer east and west, than broad north and south; and shake a zone of earth with different degrees of force in different parts of their course; viz. in proportion to the different quantities of explosive sulphureous matter in different places. These kinds of earth-

quakes are observed to be progressive, and to take time to extend to the great distances sometimes of some thousands of miles. They are an instantaneous explosion in every place near the surface of the earth; and therefore do not produce mountains and islands, as volcanoes sometimes do.

"The earthquake in London, March 2, was thought to move from eastward to westward. M. Buffon mentions an earthquake at Smyrna, in the year 1688, which moved from west to east; viz. because the first kindling probably began on the western side, and in the earthquake at London on the eastern side. And accordingly it was observed, that the reddish bows in the air, which appeared several days before that earthquake, arose in the east, and proceeded westward. It was observed, after the earthquake at Smyrna, that the castle walls, which run from east to west, were thrown down; but those from north to south stood; and that the houses on rocks stood better than those on the earth.

"M. de Buffon relates, that the vibrations of the earth, in earthquakes, have commonly been from north to south, as appears by the motion of the lamps in churches; which makes it probable, that though the progress of the earthquake at Smyrna was from west to east, yet the vibrations of the earth might be from north to south; and thereby occasion the falling of the castle walls, which run from east to west, but not those which run from north to south. A probable argument that, as the freest passage, so the greatest explosions were made in the clifts of the earth which run east and west, which would make the vibrations north and south.

"It was observed, that the waters turned foul the day before an earthquake at Bologna in Italy; and I was informed that the water of some wells in London turned foul at the time of the earthquakes. Which was probably occasioned by the ascent of great plenty of sulphureous vapours through the earth.

"As to the hollow rumbling noise, which is usually heard in earthquakes, it seems not improbable that it may be occasioned by the great agitation that the electrical ethereal fluid is put into by so great a shock of a large mass of earth. For, if the like motion of a small revolving glass globe can excite it to the velocity of lightning, and that with a force sufficient to kill animals, how much greater agitation may it probably be excited to by the explosive force of an earthquake!

"The explosion of a cannon in St. James's Park is observed to electrify the glass of the windows in the Treasury. And what makes it still more probable, is the analogy that there is between them in other respects. For, as the electrical flash rushes with the velocity of lightning along the most solid bodies, as iron, &c. and as I have seen it run only on the irregular gilding of leather; so such solid bodies are observed to be the conductors of aërial lightning, which rends oaks in pieces, and has been known to run along and melt an iron bell-wire on both sides of a room, &c. And accordingly it was observed, in the great earthquake in Jamaica, that the most tremendous roaring was in the rocky mountains. And in the late earthquake of March 8 in London, the loudest explosions were thought to be heard near such large stone buildings as churches with lofty steeples and spires.

"I, who lay in Duke's-court, near St. Martin's church, and was awake all the time of the earthquake, plainly heard a loud explosion up in the air, like that of a small cannon; which made me conjecture, that the noise was owing to the rushing off, and sudden expansion, of the electrical fluid, at the top of St. Martin's spire; where all the electrical effluvia, which ascended up along the larger body of the tower, being by attraction strongly condensed, and accelerated at the point of the weathercock, as they rushed off, made so much the louder expansive explosion."

The Rev. John Seddon observes, As soon as I felt the shock, I was immediately apprehensive what it was, and went out to see whether there was any thing remarkable in the atmosphere. I then observed a very uncommon appearance, viz. an infinite number of rays, proceeding from all parts of the heavens converged to one point; no luminous body appeared at all. The rays were at first of a bright yellow; afterwards they became blood-red. This phenomenon was not far from our zenith. It continued about twenty minutes, and then disappeared.

Dr. Dodridge, remarks: The morning on which the phænomenon happened, was remarkably calm; but quickly after the shock, the wind rose; and the clouds, which had covered the heavens for several days, were pretty much dispersed. There was a report that, at near four o'clock that morning (Sunday), a ball of fire was seen. On Monday night the sky in the east was as red as blood; and on Tuesday night was the finest aurora borealis he ever saw. He says,

that a Mr. Scawen was confident that he heard that rushing noise, so generally mentioned by all who observed any thing extraordinary, not only before, but after the shock; and that he could trace the direction, from S.W. to N.E. He adds, that a niece of Sir Hans Sloane observed, that just before the shock, her birds drooped remarkably, and hid their heads under their wings: a circumstance often observed in Italy, and other places where these phænomena are frequent.

The last of these papers is by Dr. Stukeley, on what he calls the philosophy of earthquakes: he recounts the most remarkable circumstances mentioned in the several accounts, and thence deduces a theory to explain the whole.

We have had, says he, many opportunities of reflecting on that most awful and hitherto unusual appearance. The year 1750, may rather be called the year of earthquakes, than of jubilee. For, since they began with us in London, they have appeared in many parts of Europe, Asia, Africa, and America, and have likewise revisited many counties in our island: at length, on the 30th of September, having taken their leave (as we hope) with much the most extensive shock we have seen in our days.

We have been acquainted by those that remember it, that in the earthquake of November 1703, which happened in Lincolnshire, the weather was calm, close, gloomy, warm, and dry, in a degree highly unusual at that season; and thus it has been with us all the year: and from the numerous accounts we have received at the Royal Society, in the beginning and end of the year, where any mention is made of the weather, they agree in the like particular: which is consentaneous to what is remarked as the constant forerunner of earthquakes, and what prepares the earth's surface to receive the electrical stroke.

We had a paper read at the Royal Society, concerning the first earthquake felt by us at London on the 8th of February. A shepherd belonging to Mr. Secretary Fox at Kensington, the sky being perfectly serene and clear, was much surprized with a very extraordinary noise in the air, rolling over his head, as of cannon close by. This noise passed rushing by him; and instantly he saw the ground, a dry and solid spot, wave under him, like the face of the river. The tall trees of the avenue, where he was, nodded their tops very sensibly, and quavered. The flock of sheep immediately

took fright, and ran away all together, as if the dogs had pursued them. A great rookery in the place were equally alarmed; and, after a universal clangor, flew away, as if chased by hawks.

It was likewise mentioned, that in the same earthquake, a great parcel of hens and chickens, kept at that time in Gray's-inn-lane, on the shock, ran to the roost affrighted; and the like was observed of pigeons. And in our account of the last earthquake from Northampton, it is remarked, that the birds in cages put their heads under their wings, as to hide themselves.

Mr. Jackson, potter at Lambeth, gave an account of some boats and lighters, in the river at that time; the people in them seemed to feel as if, a porpoise, or some great fish, had heaved and thumped at the bottom of the lighters. This is sometimes the case with ships at sea; which seems evidently owing to an electrical impression on the water.

In the Evening Post, June 23, we had a paragraph from Venice, that a terrible earthquake had lately been felt in the Isle of Cerigo, a little rocky isle. It threw down a great number of houses, and above 2000 inhabitants were buried in the ruins. Another earthquake about that time happened in Switzerland, which split a vast rocky mountain, and an old castle wall, of an immense thickness.

But, since then, these wonderful movements have stalked round the globe; (and been lately felt in our own island, though to the terror only of many thousand people) besides those that appeared in the western parts, in the more early time of the year.

In a letter from Maurice Johnson, Esq. the founder and secretary of the Literary Society of Spalding, which has now subsisted these forty years, he says that, on Thursday the 23d of August last, an earthquake was very sensibly felt there, about seven o'clock in the morning, throughout the whole town and neighbourhood, and many miles round; but chiefly spread northward and southward. He says, that for a fortnight before the weather had been serene, mild, and calm; and one evening there was a deep red aurora australis, covering the cope of heaven, very terrible to behold. This same shock was felt at Grantham, Stamford, and Miltonby Peterborough; and generally at all the intermediate places.

But we have had many advices from all hands, at the first and second meetings of the Royal Society for the winter season, with further par-

ticulars relating to this great concussion: that it was felt at the same time at Rugby in Warwickshire, and reached to Warwick; at Lutterworth in Leicestershire; at Leicester, and round about. They describe it, that the houses tottered, and seemed to heave up and down, though it lasted but a few seconds. It was attended with a rushing noise, as if the houses were falling; and people were universally so affrighted, as to run out, imagining that their own or neighbours' houses were tumbling on their heads. In the villages around, the people, being at divine service, were much alarmed both with the noise, which exceeded all the thunder they had ever heard, beyond compare; and with the great shock accompanying, which was like somewhat that rushed against the church-walls and roof; some thinking the pillars cracked; many, that the beams of the roof were disjointed; and all, that the whole was falling; and happy were they that could get out first. A few slates, tiles, and parts of chimnies, fell from some houses; pewter, glasses, and brass, fell from shelves; a clock-bell sometimes struck; windows universally rattled; and the like circumstances of tremor.

The same extended itself to Coventry, Derby, Nottingham, Newark; then came eastwasd to Harborough, Towcester, Northampton, Rowell, Kettering, Wellingborough, Oundle in Northamptonshire, Uppingham, Oakham in Rutland, Stamford, Bourn, Grantham, Spalding, Boston, and to Lincoln in Lincolnshire; Holbech, and other towns in that county; Peterborough, Wisbech in the Isle of Ely, together with all the intermediate and adjacent places. Then it passed over the whole breadth of Ely-Fen, and reached to Bury in Suffolk, and the country thereabouts; of which we had notice from Lady Cornwallis: and extent from Warwick to Bury of about a hundred miles in length, and generally speaking, forty miles in breadth. And this vast space was pervaded by this amazing motion, as far as we can get any satisfaction, in the same instant of time.

In regard to circumstances, they were pretty similar throughout. At Northampton, a gentlewoman, sitting in her chair, relates, that she and her chair were twice sensibly lifted up, and set down again. A stack of chimneys were thrown down in College-lane; a place retaining the memory of a sort of university once beginning at Northampton. The windows of houses rattled throughout the whole town; but no mischief done.

They fancied there the motion of it, as they expressed it, to be eastward. In streets that run north and south, the houses on the east side of the way were most affected: and Dr. Stonehouse's dwelling, the strongest in the town, was most sensibly shaken. So it was likewise observed, that churches were most subject to its violence. They thought too that the motion seemed rather horizontal, or lateral than upward. Some counted the pulses distinctly, to the number of four. That the second and third pulse were stronger than the first and fourth. From all there various accounts, there was no sulphureous smell or eruption, no fissures in the ground perceived, yet several people were sick upon it.

It was more evidently perceived by people standing; most, by those that were sitting; least, by such as were walking; and in upper stories of houses more than in lower, or cellars. Some, coming down stairs, were in danger of being thrown forwards: several sitting in chairs, and hearing the hollow thundering noise, and thinking it was a coach passing by, when they attempted to get up to see what it was, they were thrown back again into their chair. Some heard the wainscot crackle. A lady, sitting by the fire, with her chair leaning forwards, was thrown down on her hands and knees.

It was particularly remarked (as before mentioned), that birds in cages were sensibly affrighted, thrusting their heads under their wings. Mrs. Allicock, of Loddington, a lady in childbed, was so affected that it caused her death. Some people felt such a sudden shortness of breath, that they were forced to go out into the open air, it so affected the pulmonary nerves. Many were taken with head-achs.

These are, in general, the observations made at the time of these earthquakes. Give me leave now to make the following remarks.

1. As far as we can possibly learn, where no one can be prepared at different places by time-keepers, this mighty concussion was felt precisely at the same instant of time, being about half an hour after twelve at noon. This, I presume, cannot be accounted for by any natural power, but that of an electrical vibration, which we know acts instantaneously.

2. Let us reflect on the vast extent of this trembling, 100 miles in length, 40 in breadth, which amounts to 4000 square miles in surface. That this should be put into such an agitation in one moment, is such a prodigy, as we should never believe, or conceive, did

we not know it to be a fact, from our own senses. But if we seek for a solution of it, we cannot think any natural power is equal to it, but that of electricity; which acknowledges no sensible transition of time, no bounds.

3. We observe, the vulgar solution of subterraneous eruptions receives no countenance from all that was seen or felt during these earthquakes: it would be very hard to imagine how any such thing could so suddenly and instantaneously operate through this vast space, and that in so similar and tender a manner, over the whole, through so great a variety as well as extent of country, as to do no mischief.

A philosophical inquirer in Northamptonshire, who had his eye particularly on this point, takes notice that there were not any fissures in the ground, any sulphureous smells, or eruptions, any where perceived, so as to favour internal convulsions of the earth; yet we learn, from a letter, at Uppingham in Rutland, that a plaster floor became cracked thereby. These kind of floors are frequent in this country, what we call stucco in London; and it gives us a good notion of the undulatory vibration produced by an earthquake; which some have compared to that of a musical string; others, to that of a dog, or a horse, shaking themselves when they come out of the water.

4. The former earthquake, that happened at Grantham, Spalding, Stamford (which towns lie in a triangle) took up a space which may in gross be accounted a circle of twenty miles in diameter; the centre of which is that great morass called Deeping-Fen. This comprehends fourteen miles of that twenty in diameter; and where, probably, the electrical impression was first made. Much the major part of Deeping-Fen is under water in the winter; underneath is a perfect bog; now it is very obvious how little favourable such ground is for subterraneous fires.

In the second earthquake, not only this country was affected again, but likewise a much larger space of the same sort of fenny ground, rather worse than the former: all Donington-Fen, Deeping-Fen, Croyland-Fen, Thorny-Fen, Whittlesea-Fen, Bedford-Level, and the whole extent of Ely-Fen, under various denominations. This country, under the turf, abounds with subterraneous timber of all kinds; fir, oak, and brush-wood; stags' horns: now and then they find a quantity of hazel nuts, crouded together on a heap: I

have some of them. This is a matter common to all boggy ground over the whole globe. They are the ruins of the antediluvian world, washed down from the high country, where they grew, here lodged, and by time overgrown with the present turf.

5. All this country, though underneath it is a watery bog, yet, through this whole summer, and autumnal season (as they can have no natural springs in such a level) the drought has been so great on the superficies, that the inhabitants were obliged every day to drive their cattle several miles for watering. This shows how fit the dry surface was for an electrical vibration; and we learn from hence this important particular, that it reaches but very little below the earth's surface.

Mr. Johnson, in another letter which he wrote concerning the second earthquake observed at Spalding, says, on this occasion he was obliged to scour his canal, and deepen it; that they came to a white quicksand, which afforded to all the neighbourhood excellent water in plenty.

In the gravelly soil of London, and where the two shocks were felt by us in the beginning of the year, we know there is not a house in the whole extent of this vast city, and all around it, but a spring of water is ready on digging a well: whence we have much reason to believe, that the internal parts of the earth are like a sponge soaked in water, so that the only dry part of it is the superficies; which is the object and the subject of that electric vibration wherein it seems an earthquake consists. This shows the mistake of the ancients; who, fancying that earthquakes proceeded from subterraneous eruptions, built their prodigious temple of Diana of Ephesus on a boggy ground, to prevent such a disaster.

6. Earthquakes are truly most violent in a rocky country; because the shock is proportionate to the solidity of the matter electrified: so that rocks, old castle walls, and strong buildings, are most obnoxious to the concussion. The Isle of Cerigo was more liable, and more rudely treated by the late earthquake, both because it was an isle, and because it was rocky. So we may say of the late earthquake in Switzerland, that split the mountain and the old castle wall. Whence Mr. Johnson, in his second letter, says, it cracked a very strong brick house in Gosberton by Spalding. Dr. Dodridge observes, from Northampton, that Dr. Stonehouse's dwelling, being a very strong one, was most sensibly shaken. And, throughout the

whole extent of this great earthquake, we find both the noise, the shock, and the terror, was greatest at the churches, whose walls and bulk made more resistance than houses; and, generally speaking, the churches throughout this whole extent have very fair and large towers, and many remarkable spires of good stone.

This same vibration, impressed on the water, meeting with the solid of the bottom of ships and lighters, gives that thump felt there. Yet, of the millions of ordinary houses over which it passed, not one fell: a consideration which sufficiently points out to us what sort of a motion this was not; what sort of a motion this was; and whence derived: not a convulsion of the bowels of the earth, but a uniform vibration of its surface, aptly thought like that of a musical string; or what we put a drinking-glass into, by rubbing one's finger over the edge; which yet, brought to a certain pitch, breaks the glass; undoubtedly an electric repulsion of parts.

7. We find, from all accounts ancient and modern, that the weather preceding these shocks was mild, warm, dry, serene, clear, frosty: what notoriously favours all our electrical experiments. We very well know, that generally all last winter, spring, summer, and autumn, have been remarkably of this kind of weather; more so than has been observed in our memory; and have had all those requisites, appearances, and preparations, that notoriously cause electricity, that promote it, or that are the effects of it.

8. We find the blood-red australis aurora preceding at Spalding, as with us at London. This year has been more remarkable than any for fire-balls, thunder, lightning, and coruscations, almost throughout all England. Fire-balls more than one were seen in Rutland and Lincolnshires, and particularly observed. All these kinds of meteors are rightly judged to proceed from a state of electricity in the earth and atmosphere.

Mr. Johnson, in both his letters on the first and second earthquakes at Spalding, remarks particularly of their effects being mostly spread to the north and south, and especially felt on the sea-coast. We may observe that such is the direction of Spalding river, which both conducts and strengthens the electric vibration; conveying it along the sea-shore, thence up Boston channel, and so up Boston river to Lincoln; as we discern, by casting our eye upon a map.

We observe further, that the main of this second earthquake displayed its effects along and between the two rivers Welland and

Avon; and that from their very origins down to their fall into the sea. It likewise reached the river Witham, which directed the electric stream that way too to Lincoln: for which reason, as there meeting the same coming from Boston, the shock was most sensibly felt. It reached likewise to the Trent at Nottingham, which conveyed it to Newark.

The first electrical stroke seems to have been made on the high ground above Daventry in Northamptonshire, where are the Roman camps, made by P. Ostorius, the propraetor. Thence it descended chiefly eastward, and along the river Welland, from Harborough to Stamford, Spalding, and the sea; and along the river Avon, or Nen, to Northampton, Peterborough, and Wisbech, to the sea. It spread all over the vast level of the Isle of Ely, assisted by many canals and rivers, natural and artificial, made for drainage. It was still conducted eastward, up Mildenhall river in Suffolk, to Bury, and the parts adjacent. All this affair, duly considered, is a confirmation of the doctrine I advanced on this subject.

10. I apprehend it was not the noise in the air, as of many cannon let off at once, preceding the earthquake, that so much affrighted people, or affected the sheep, the rookery at Kensington, the hen and chickens in Gray's-inn-lane, and the pigeons; it could not be barely the superficial movement of the earth that disturbed them all at once: I judge it to be the effect of electricity, somewhat like what causes sea-sickness; such a sort of motion as we are not accustomed to. So the earthquake affects all those of weak nerves, or that have nervous complaints, obnoxious to hysterics, colics, rheumatic pains in their joints. Several women were seized with violent head-achs, before both the shocks we felt in London. It was this that affected the people with a shortness of breath. This made the dog run whining about the room, seeking to get out: this made the fishes leap up in the pond at Southwark; like the experiment of electrifying the fishes; it makes them sick: and this causes the birds in cages to hide their heads under their wings, because they cannot fly away: which is commonly observed of them in Italy, and countries where earthquakes are more frequent.

11. I observe, the shepherd of Kensington thought the motion of the earthquake, and the sound, were from N. W. to S. E. On the contrary, Mr. Byfield, the scarlet-dyer, in Southwark, thought the noise came from the river below-bridge, and went towards

Westminster; where it rattled so, that he did not doubt but that the abbey-church was beaten down. Dr. Parsons took pains to find out the way of the motion of the earthquake, from the different position of the beds: but from the contradictory answers given, he could obtain no satisfaction as to that point. All this, and what was observed from Northampton, of the motion being thought by some to be upward and downward, by others, rather horizontal or lateral, the counting the pulses, and the like, only points out to us the prodigious celerity, and the vibratory species of the motion of an earthquake, but far, very far, is this from being owing to the tumultuous ebullition, the irregular hurry of subterraneous explosions.

12. How the atmosphere and earth are put into that electric and vibratory state, which prepares them to give or receive the snap, and the shock, which we call an earthquake, what it is that immediately produces it, we cannot say; any more than we can define what is the cause of magnetism, or of gravitation, or how muscular motion is performed; or a thousand other secrets in nature.

We seem to know, that the Author of Nature has disseminated ethereal fire through all matter; by which these great operations are brought about. This is the subtle fluid of Sir Isaac Newton, pervading all things; the occult fire diffused through the universe, according to Marcilius Ficinus, the platonic philosopher, in the Timæus of his master. And the Platonists insist on an occult fire passing through and agitating all substance by its vigorous and expansive motion.

Before them, Hippocrates writes in the same sense, 1. De victus ratione, that this fire moves all in all. This ethereal fire is one of the four elements of the ancients; it lies latent, and dispersed through all the other three, and quiescent; till collected in a quantity that overbalances the circumjacent: like the air crowded into a tempest; or till it is excited by any proper motion.

This fire gives elasticity, and elasticity, or vibration, is the mother of electricity. This fire is in water, and betrays itself to our senses in salt water. Many a time when I have passed the Lincolnshire washes in the night-time, the horse has seemed to tread in liquid flames. The same appearance is often at the keel of a ship.

The operation of the ethereal fire is various, nay infinite, according to its quantity, and degree of incitement, progress, hindrance, or furtherance. One degree keeps water fluid, says the learned

Bishop of Cloyne; another turns it into elastic air; and air itself seems nothing else but vapours and exhalations rendered elastic by this fire.

This same fire permeates and dwells in all bodies, even diamond, flint, and steel. Its particles attract with the greatest force, when approximated. Again, when united, they fly asunder with the greatest celerity. All this is according to the laws prescribed by the Sovereign Architect. This is the life and soul of action and re-action in the universe. Thus has the Great Author provided against the native sluggishness of matter! light, or fire, in animals, is what we call the animal spirits; and is the author of life and motion. But we know not the immediate mode of muscular motion, any more than how, in inanimate matter, it causes the vibrations of an earthquake.

13. The great question then with us is, how the surface of the earth is put into that vibratory and electric state by heat and dryness? We must needs acquit the internal of the earth from the charge of these superficial concussions. How is the ethereal fire crowded together, or excited, so as to cause them; seeing, in our ordinary electrical experiments, we make use of friction?

But that friction alone does not excite electricity, we know, from the obvious experiment of flint and steel; where the suddenness of the stroke, and hardness of the matter does it. Another method of exciting it, is the letting-off a number of great guns; which so crowds the etherial fire together, as to electrify glass windows; observed by Dr. Stephen Hales. The aurora borealis, australis, all kind of coruscation, meteors, lightning, thunder, fireballs, are the effects, and may reciprocally be the cause of electricity; but how, in particular, we know not.

Come we to the animal world, we must needs assert, that all motion, voluntary and involuntary, generation, even life itself, all the operations of the vegetable kingdom, and an infinity more of nature's works, are owing to the activity of this electric fire; the very soul of the material world. And, in my opinion, it is this alone that solves the famous question, so much agitated with the writers in medicine, about the heat of the blood. How these, how earthquakes, are begun and propagated, we are yet to seek.

We may readily enough presume, that the contact between the electric and the non-electric, which gives the snap, and the shock,

must come from without, from the atmosphere; perhaps by some meteor, that crowds the etherial fire together, causes an accension in the air, in the point of contact, on the earth's surface; perhaps another time by a shower of rain. We may as readily conclude, that, though the original stroke comes from the atmosphere, yet the atmosphere has no further concern in it; no aerial power, or change therein, can propagate itself so instantaneously over so vast a surface as four thousand miles square: Therefore the impetuous rushing noise in the air, accompanying the shock, is the effect, not the cause. But surely there is not a heart of flesh that is not affected with so stupendous a concussion. Let a man estimate his own power with that which causes an earthquake, and he will be persuaded that somewhat more than ordinary is intended by so rare and wonderful a motion.

That great genius Hippocrates makes the whole of the animal economy to be administered by what we call nature, and nature alone, says he, suffices for all things to animals: she knows herself, and what is necessary for them. Can we deny then that he here means a conscious and intelligent nature, that presides over, and directs all things; moves the ethereal spirit or fire, that moves all things; a divine necessity, but a voluntary agent, who gives the commanding nod to what we commonly call nature; the chief instrument in the most important operations of the vast machine, as well as in the ordinary ones? And this leads us,

14. Lastly, in regard to the spiritual use we ought to make of these extraordinary phænomena, or of our enquiries about them; I shall first observe, that we find abroad, shat several of these earthquakes this year have been very fatal. In the last we read of at Philippoli in Thrace, the whole city was destroyed, and above four thousand inhabitants killed. At home, where above half a score separate concussions have been felt, there has not been one house thrown down, one life lost. This ought to inspire us with a very serious reflection about them. We may observe, that if we did but read the works of Hippocrates, Plato, and his followers, of Tully, Galen, and the like ethic writers of antiquity, whilst we study and try the affections of matter, we should improve in philosophy, properly speaking; we should lift up our minds from these earthly wonders, and discern the celestial monitions they present to us.

The original meaning of the word philosophy was rightly applied

to moral wisdom; we, who have improved both, should join them both together. By this means we gather the truth of the highest and most excellent philosophy, to be found in those volumes of first antiquity, which we call sacred; and we should adore that divine light which they hold forth to us; especially in a country where the principles of true religion are open and undisguised; where the established profession of it is rational, noble, and lovely; worthy of the moral governor of the world.

[*Phil. Trans. abridged, Vol. X.*]

CHAP. XX.

EXTENSIVE EARTHQUAKE OF THE YEAR 1755.

THE earthquake of the above was certainly the most horrible and extensive of modern times, nor have we any account of any thing that can be compared to it in ancient history. Its origin appears to have been under the Atlantic Ocean, the waves of which were shaken almost as violently as the land; its range extended over a part of both the hemispheres, and more or less affected Europe, Africa and America, though it was in the south-western parts of Europe, in which its violence and devastation were chiefly conspicuous, and especially in the city of Lisbon, which fell a victim to its fury. We shall give the following details in the order in which they are communicated in the abridgment of the Philosophical Transactions.

SECTION I.

Account of the Earthquake at Lisbon, November 1st, 1755, from Mr. Wolfall.*

SINCE the beginning of the year 1750, we have had much less rain than has ever been known in the memory of man, excepting

* This city also suffered greatly by an earthquake in 1531. *Orig.* And since the above period, in 1761, 1765, and 1772, though never with a ruin in any degree equal to that of 1755.—*Editor.*

the last spring; the summer has been cooler than usual, and for the last forty days, fine clear weather, but not remarkably so. On the first instant (Nov. 1755,) about forty minutes past nine in the morning, was felt a most violent shock of an earthquake; it seemed to last about the tenth part of a minute, and then came down every church and convent in town, together with the King's palace, the magnificent opera-house, joining to it; in short, there was not a large building in town that escaped. Of the dwelling-houses, there might be about one-fourth of them that tumbled, which, at a very moderate computation, occasioned the loss of thirty thousand lives. The shocking sight of the dead bodies, and the shrieks and cries of those who were half-buried in the ruins, are only known to those who were eye-witnesses. It far exceeds all description, for the fear and consternation was so great, that the most resolute person durst not stay a moment to remove a few stones off the friend he loved most, though many might have been saved by so doing; but nothing was thought of but self-preservation; getting into open places, and into the middle of streets, was the most probable security. Such as were in the upper stories of houses, were in general more fortunate than those that attempted to escape by the doors; for these were buried under the ruins with the greatest part of the foot-passengers; such as were in equipages escaped best, though their cattle and drivers suffered severely; but those lost in houses and the streets, are very unequal in number to those that were buried in the ruins of churches; for as it was a day of great devotion, and the time of celebrating mass, all the churches in the city were vastly crowded, and the number of churches here exceeds that of both London and Westminster; and as the steeples are built high, they mostly fell with the roof of the church, and the stones are so large, that few escaped.

Had the misery ended here, it might in some degree have admitted of redress; for though lives could not be restored, yet the immense riches that were in the ruins, might in some part have been digged out; but the hopes of this are almost gone, for in about two hours after the shock, fires broke out in three different parts of the city, occasioned by the goods and the kitchen-fires being all jumbled together. About this time also the wind, from being perfectly calm, sprung up a fresh gale, which made the fire rage with such fury, that at the end of three days all the city was reduced to cinders.

Indeed every element seemed to conspire to our destruction; for soon after the shock, which was near high water, the tide rose forty feet higher in an instant than was ever known, and as suddenly subsided. Had it not so done, the whole city must have been laid under water. As soon as we had time for recollection, nothing but death was present to our imaginations. For, 1st, the apprehensions of a pestilence from the number of dead bodies, and the general confusion, and want of people to bury them, were very alarming; but the fire consumed them, and prevented that evil. 2d. The fears of a famine were very great; for Lisbon is the store-house for corn to all the country, for fifty miles round; however, some of the corn-houses were happily saved, and though the three succeeding days to the earthquake an ounce of bread was worth a pound of gold, yet afterwards bread became moderately plenty, and we were all happily relieved from our starving condition.

The 3d great dread was, that the low villainous part of the people would take an advantage of the confusion, and murder and plunder those few who had saved any thing. This in some degree happened; on which the king gave orders for gallows immediately to be placed all round the city; and after about a hundred executions, among which were some English sailors, the evil stopped. We are still in a state of the greatest uncertainty and confusion, for we have had in all twenty-two different shocks since the first, but none so violent as to bring any houses down in the outskirts of the town, that escaped the first shock; but nobody yet ventures to lie in houses; and though we are in general exposed to the open sky for want of materials to make tents, and though rain has fallen several nights past, yet the most delicate tender people suffer their difficulties with as little inconvenience as the most robust and healthy. Every thing is yet with us in the greatest confusion imaginable; we have neither clothes nor conveniences, nor money to send for them to other countries. All Europe is deeply concerned in the immense riches and merchandizes that are lost, but none so much as our own nation, who have lost every thing they had here. Few English lives have been lost in comparison of other nations, but great numbers wounded; and though we have three English surgeons here, they are unfortunately without either instruments, bandages, or dressings to relieve them. Two days after the first shock, orders were given to dig for the bodies, and a great many have been taken up and

recovered. Mr. W. lodged in a house where there were thirty-eight inhabitants, and only four saved. In the city prison eight hundred were lost. Twelve hundred in the general hospital, a great number of convents of four hundred in each lost; the Spanish ambassador with thirty-five servants. It fortunately happened, that the king and the Royal Family were at Belime, a palace about a league out of town. The palace in town tumbled the first shock, but the natives insist that the Inquisition was the first building that fell down. The shock has been felt all over the kingdom, but along the sea-side more particularly. Faro, St. Ubals, and some of the large trading towns are, if possible, in worse situation than here; though the city of Porto has quite escaped.

It is possible, that the cause of all these misfortunes came from under the western ocean; for a captain of a ship, a very sensible man, told him that he was fifty leagues off at sea; that the shock was there so violent as greatly to injure the deck of his ship; it occasioned him to think that he had mistaken his reckoning, and struck upon a rock, and they instantly hauled out their long-boat to save themselves, but happily brought the ship, though much injured, into this harbour.

The shocks lasted between five and seven minutes. The very first shock was extremely short, but then it was as quick as lightning succeeded by two others, which, in the general way of speaking, are mentioned all together as only one shock. About twelve o'clock we had a second shock. Mr. W. was then in the Terra do Paco, or King's palace-yard, and had an opportunity of seeing the walls of several houses that were standing, open from top to bottom, more than a quarter of a yard, yet close again so exactly as to leave no signs of injury.

SECTION III.

Abstract of Two Letters, by John Mendes Saccheti, M.D. F.R.S. dated from the Fields of Lisbon, on the 7th of November, and the 1st of December, 1755.

The day before the fatal earthquake the atmosphere, and the light of the sun, had the appearance of clouds and notable offuscation, and more strong and visible at the actual time of the great shock, which was by undulation, and lasted from six to eight mi-

nutes. It ruined not only this populous city, but all the southern part of the country of Estramadura, and a great part of the kingdom of Algarve. The earth opened in fissures in several parts, but neither fire nor visible smoke came out of it. The water in the sea rose several times, and in a few minutes made three fluxes and refluxes, rising above the greatest spring-tides two spawns or fifteen English feet.

SECTION IV.

Abstract of a Letter from Mr. J. Latham, dated at Zsu-queira, Dec. 11, 1755, to his Uncle in London.

I WAS on the river on Saturday the 1st of November, with a gentleman going to a village three miles off. In a quarter of an hour the boat made a noise as if on the shore or landing. About four or five minutes after, the boat made a noise as before, which was another shake. We saw the houses tumble down on both sides of the river. In Lisbon, a convent on a high hill fronting the river, the most part of it came down, a great many were killed and buried in the ruins; many tumbled neck and heels in the water, others ran down to the river, up to their middle and necks. A strong northerly wind blew from the shore, which covered the water with dust, and in our boat we could scarcely see one another; and it entirely hid the sun from us for some time. The wind soon dispersed the dust, the shaking seemed over. In about three quarters of an hour we came to the village, where we were called ashore, and met several gentlemen, who came out of the city on horseback, but so frighted, that they did not know what was the matter. In a quarter of an hour after our landing, the village was alarmed with another shake. We got down to our boat; in a moment the river rose so high as obliged us to take to our heels, and run for our lives into the fields and high ground, the water flowing across the road, which, from the low tide, was above a quarter of a mile; the ships were whirled about, and several people taken into the water, others driven ashore and dashed to pieces. From the high grounds we could see the sea at about a mile's distance come rushing in like a torrent, though against wind and tide. A fine new stone quay in Lisbon, where the merchants land their goods, where at that time about three thousand people were got out for safety, was turned

bottom upwards, and every one lost; nor did so much as a single body appear afterwards. It being a holiday, great numbers of the natives being at their devotion in convents and churches, whose large buildings suffered most, it was computed about sixty thousand souls, and a hundred and odd of the foreigners, and all sorts of cattle, perished. The religious houses being illuminated with wax-lights, and the images dressed, by the shakes were set on fire by night, in several places, and by Monday morning entirely consumed, with the rich furniture of convents, nunneries, and nobility's houses, and all the merchants and tradesmen's goods, besides jewels, gold, plate, and coined money. There have been a great many shakes by nights and days; even on the 8th of December was felt a strong one; it was much more violent in some places than others. The ground was opened; in some places you might put your hand down broadways, and not feel the bottom with a long-stick. A sea-port, called St. Ubal's, was entirely swallowed up, people and all.

SECTION V.

*Observations made at Colares *, on the Earthquake at Lisbon, of the 1st of November 1755, by Mr. Stoqueler, Consul of Hamburg.*

THE first of November, the day broke with a serene sky, the wind continuing at east; but about nine o'clock the sun became dim, and about half an hour after we began to hear a rumbling noise, like that of carriages, which increased to such a degree as to equal the noise of the loudest cannon; and immediately we felt the first shock, which was succeeded by a second and third; on which, as also on the fourth, were seen several light flames of fire issuing from the sides of the mountains, resembling what is observed on the kindling of charcoal. In the spot on which he remained till the third shock was over, he observed the walls to move from east to west.

In the afternoon of the 31st of October, the water of a fountain was greatly decreased; on the morning of the 1st of November it ran very muddy, and after the earthquake it returned to its usual state, both in quantity and clearness. Some fountains, after the earthquake, ran muddy, some decreased, others increased, others

* It is about twenty miles from Lisbon, and lies behind the rock, about two miles from the sea.—Orig.

were dried up; and one, that with the earthquake was dried up entirely, returned two days after to its usual state. In some places where there was no water, springs burst forth, which continued to run. On the spot of Varge, and river of Macaas, at the time of the earthquake, many springs of water burst forth, and some spouted to the height of twenty-five palms*, throwing up sand of various colours, which remained on the ground. On the hills numbers of rocks were split, and there were several rents in the ground, but none considerable. On the coast, pieces of rock fell, some of them very large, and in the sea sundry rocks were broken: the most noted are those called by the sailors Sarithoes, or Biturecras, of which one was only broken off at the summit, the other all to pieces.

Between these rocks and the main, the coasting vessels sailed at low water; and now you may go to them at low water, without wetting your feet. From the rock called Pedra de Alvidrar, a kind of parapet was broke off, which issued from its foundation in the sea. In a swamp or lake, which received a good deal of water in winter, and was not dry in summer, the earth rose; for there is now scarcely the appearance of a hollow, which was before to the depth of six or seven palms; it now remains even with the adjacent ground. In other places, by the change of the currents it appears that the earth was moved, so that some spots are more elevated, and others more depressed than before.

SECTION VI.

Concerning the Earthquake at Oporto in Portugal, Nov. 1, 1755. By a Letter from that place.

SATURDAY, November 1st, we had such a terrible earthquake here, that we were afraid of being swallowed up alive, though it has done but very little damage. It began at about half an hour past nine o'clock in the morning, like thunder, or rather the rattling of a coach over stones; and my own house, as well as most other people's, during the first shock, which was a very terrible one indeed, was just as if in a convulsion, which lasted seven or eight minutes, and every thing shook and rattled in it all the time, as if it was

* The Portuguese palm is about nine inches.—Orig.

coming down; which frightened people so much, that a great many ran into the streets, where I plainly saw the earth heave up. At six o'clock at night there was another great shock. The river also rose and fell surprizingly every quarter of an hour, and upwards of four hours at least, four or five feet, and sometimes more; and some saw the river in some places open, and throw out a vast deal of wind, which was very terrifying.

SECTION VII.

Abstract of Two Letters from Mr. Plummer, Merchant in London, from Oporto, concerning the Earthquake felt there.

THIS morning, November 1, 1755, between nine and ten o'clock, this city was alarmed with the terrible shock of an earthquake, which continued violently for five or six minutes, but has done no further damage than the overturning some pedestals from the tops of some churches, and splitting the walls of some old houses. The shock was perceived in the river, among the shipping, by a sudden flux and reflux of the tide, but no damage was done. During the time of the earthquake, and indeed preceding it, was heard a hollow dreadful noise.

SECTION VIII.

Abstract of a Letter from Madrid to the Spanish Consul in London.

NOVEMBER 1, soon after ten o'clock, there was very sensibly felt a great earthquake: according to the common opinion, it lasted five or six minutes. Every one at first thought that they were seized with a swimming in their heads; and afterwards that their houses were falling. The same happened in the churches, so that the people trod each other under foot in getting out; and those who observed it in the towers were very much frightened, thinking that they were tumbling to the ground. It was not felt by those who were in their coaches, and very little by those who walked on foot.

SECTION IX.

Of the Earthquake at Cadiz, November 1, 1755, in a Letter from Mr. Benjamin Bewick, Merchant there.

NOVEMBER 1, just before ten, the whole town was shaken with a violent earthquake, which lasted above three minutes and a half. The water in the cisterns, which are underground, washed backward and forward, so as to make a great froth upon it. Every body ran out of the houses and churches, in a terrible consternation, but no damage was done, as all the buildings here are excessively strong. An hour after, looking out to sea, we saw a wave coming at eight miles distance, which was at least sixty feet higher than common. Every body began to tremble; the centinels left their posts, and well they did: it came against the west part of the town, which is very rocky; the rocks abated a great deal of its force. At last it came upon the walls, and beat in the breast-work, and carried pieces of eight or ten tons weight, forty and fifty yards from the wall, and carried away the sand and walls, but left the houses standing, so that only two or three persons were drowned. Every one now thought the town would be swallowed up; for though this was run off, yet with glasses we saw more coming. When the wave was gone, some parts, that are deep at low water, were quite dry, for the water retired with the same violence that it came with. These waves came in this manner four or five times, but with less force each time; and about one the sea became more calm, but was still in a boiling motion. Every thing was washed off the mole. The bay was full of barrels, and boats, and timber; but no damage was done to the shipping. The walls have suffered very much. Some of the towns about us have suffered a great deal more than we, by the falling of houses and towers.

SECTION X.

Of the Earthquake at Cadiz. By Don Antonio d'Ulloa, F.R.S.

NOVEMBER 1, we had here an earthquake, the violence of which was not inferior to that which swallowed up Lima and Callao, in Peru, towards the end of October 1746. It happened in very fine weather, at three minutes after nine in the morning, and continued

five minutes, and consequently near twice as long as that of Peru, the duration of which was only three minutes. If every thing was not destroyed here, it seems particularly owing to the solidity of the buildings. The inhabitants had scarcely begun to recover from their first terror, when they saw themselves plunged into new alarms. At ten minutes after eleven they saw rolling towards the city a tide of the sea, which passed over the parapet of sixty feet above the ordinary level of the water. At thirty minutes after eleven came a second tide; and these two were followed by four others of the same kind, at fifty minutes after eleven, at twelve o'clock thirty minutes; one o'clock ten minutes; and one o'clock fifty minutes. The tides continued, with some intervals, till the evening, but lessening. They have ruined a hundred toises of the rampart; part of which of three toises length, and of their whole thickness, were carried by the torrent above fifty paces. A great number of persons perished on the causey, which leads to the isle of Lesu. Seville has been greatly damaged. St. Lucar and Cheres have likewise suffered much; and Conel is said to be entirely destroyed.

SECTION XI.

An Account of the Earthquakes that happened in Barbary, inclosed in a Letter from General Fowke, Governor of Gibraltar. Communicated by Philip, Lord Viscount Royston, F.R.S.

AT Tetuan the earthquake began, the 1st of November, at ten in the morning, and lasted between seven and eight minutes; during which space the shock was repeated three different times, with such violence, that it was feared the whole city would fall down; but the only damage that resulted was the opening or parting of some of the walls of sundry houses. It was likewise observed, that the waters of the river Chico, on the other side of the city, and those of a fountain, appeared very red.

At Tangier, the earthquake began about the same time, but lasted longer than at Tetuan; the trembling of the houses, mosques, &c. was great, and a large promontory of an old building near the city gate, after three shocks, fell down to the ground, by which five shops were demolished; the sea come up to the very walls, a thing never seen before, and went down directly with the

same rapidity as it came up, as far as the place where the large vessels anchor in the bay, leaving upon the mole a great quantity of sand and fish. These commotions of the sea were repeated eighteen times, and continued till six in the evening, though not with such violence as at the first time. The fountains were dried up, so that there was no water to be had till night; and as to the shore-side, the waters came up half a league inland.

At Arzila, it happened about the same time, but the damage was not great. At the coming up of the sea seven Moors, who were out of the town-walls, were drowned; and the waters came in through one of the city gates very far. The water came up with such impetuosity, that it lifted up a vessel in the bay, which, at the waters's falling down to its centre again, fell down with such a force upon the land, that it was broke to pieces, and a boat was found at the distance of two musket-shots within-land from the sea.

At Salle there happened very great damage, several houses having fallen down. The waters came up with such rapidity, that they came into the city, and at their falling down, great quantites of fish were found in the streets, and many persons were drowned; two ferry-boats overset in the river, and all the people on board were also drowned; and a great number of camels, that were just then going for Morocco, were carried away by the waters.

At Fez, vast numbers of houses fell down, and a great many people were buried under the ruins. At the Scloges, a place where the barbarians live, not far from Fez, a mountain broke open, and a stream issued out as red as blood.

At Mequinez, a vast number of houses fell down, and a great many people of both sexes were buried under their ruins; the convent of the Franciscan friars fell down to the ground, but the friars were saved.

At Saffe, several houses fell down, and the sea came up as far as the great mosque, which is at a great distance from the sea.

At Morocco, by the falling down of a great number of houses many people lost their lives; and about eight leagues from this city, the earth opened, and swallowed up a village, with all the inhabitants, (who were known by the name of the sons of Busunba) to the number of about eight or ten thousand persons, with their cattle of all sorts as camels, horses, horned cattle, &c. and soon after the earth was closed again, in the same manner as it was before.

At Fez and Mequinez, on the 18th of November there happened another earthquake, which was more violent than the first, and lasted till break of day the 19th; during which time great numbers of houses fell down at Fez; many people of both sexes were buried under their ruins; and as to Mequinez, there are but few houses left standing. The people killed by the falling of the houses, besides the wounded, are numberless; and in the part of the town called the Jews' Habitation, only eight persons were saved.

At Sarjon Hills, one of the hills was rent in two; one side of which fell on a large town, where there was the famous sanctuary of their prophet, known by the name of Mulay Teris; and the other side of the said hill fell down on another large town, and both towns and the inhabitants were all buried under it.

The famous city of Tasso was wholly swallowed up; no remains left.

This last earthquake was likewise felt at Tetuan and Tangier, but without any other damage than that the fountains of Tangier were dried up for twenty-four hours.

SECTION XII.

Of the Earthquake in the Island of Madeira, Nov. 1, 1755, in a Letter from Dr. Thomas Heberden, to his Brother Dr. Wm. Heberden, F.R.S.

NOVEMBER 1, 1755, in the city of Funchal, on the island of Madeira, at half an hour past nine o'clock in the morning, was perceived a shock of an earthquake. The first notice was a rumbling noise in the air, like that of empty carriages passing hastily over a stone pavement; immediately the floor moved with a tremulous motion, vibrating very quickly; the windows rattled, and the whole house seemed to shake. The shock lasted a full minute; during which the vibrations, though continual, abated and increased twice very sensibly, in point of force. The noise in the air, which had preceded the shock, continued to accompany it; and lasted some seconds after the motion of the earth had entirely ceased; dying away like a peal of distant thunder rolling through the air. The direction of the shock seemed to be from east to west.

About an hour and half after the shock had ceased, the sea, which was quite calm, was observed to retire suddenly some paces,

and rising with a great swell, without the least noise, as suddenly advancing, overflowed the shore, and entered into the city. It rose full fifteen feet perpendicular, above high water mark; though the tide, which ebbs and flows here seven feet, was then at half ebb. The water immediately receded again, and after having fluctuated four or five times between high and low water mark, the undulations continually decreasing, it subsided, and the sea remained calm.

In the northern part of this island the inundation has been more violent, the sea there retiring at first above one hundred paces, and suddenly returning, overflowed the shore, destroying or damaging several houses and cottages, forcing open doors, and breaking down the walls of several stores or magazines, and carrying away in its recess a considerable quantity of grain, &c. Great quantities of fish were left on the shore, and in the streets of the village of Machico. All this has been the effect of one sole undulation of the sea, it never flowing afterward so high as high-water mark; though it continued fluctuating much longer there, before it subsided, than here at Funchal, as the fluctuation and swell was much greater here than it had been farther to the westward, where in some places it has been hardly, if at all, perceptible.

SECTION XIII.

Of the late Earthquakes of Nov. 1, and Dec 9, 1755, as felt at Neufchatel, in Swisserland. By Mons. De Vautravers, F. R. S.

THE dreadful earthquake of the 1st of November last has been perceived even in this country, though very faintly. It turned some of our rivers suddenly muddy, without any rain, and swelled our lake of Neufchatel to the height of near two feet above its natural level, for the space of a few hours.

The 9th of this month (Dec.) we felt a much more severe shock of an earthquake. It happened a little before three o'clock in the afternoon, with a vibratory motion from west to east, and a third from west to east again. Some chimnies fell in at Cudefrin; the bell in the tower at Morat rung two strokes. The shock was severer in lofty places than it was in low grounds. The lake of Morat, immediately after the earthquake, sunk three inches, and remains still in the same depression. The same earthquake was felt the same day, at the same hour, at Basil, Berne, Fribourg, Geneva, and all over Swisserland: as likewise at Besançon, in France.

SECTION XIV.

Of the Earthquake felt at Geneva, Dec. 9, 1755, by Mons. Trembley.

THE earthquake of November 1, was felt at Lyons. It is said that the waters retired for some moments at the end of the lake of Geneva; and that a motion was observed in those of the lake of Zurich. On the 9th of this month (December) a little before half an hour after two in the afternoon, in very fine and very calm weather, there was felt here in all the houses in general a very great shock of an earthquake; but it did no damage. The motion was particularly remarked in looking-glasses and windows. Those who were sitting perceived that their chairs shook; and many thought that they were going to fall. The sick felt the motion in their beds. The bells in the rooms of several houses rang. The bell of the clock in the tower of the isle of Rhone rung several times. The motion was felt even on the ground-floor of houses. It was felt at Nion, Morges, Lausanne, Berne, Zurich, and perhaps more strongly than here. Three shocks were in fact felt within the space of about a minute. During the first a noise was heard like that of a cart passing over a pavement.

SECTION XV.

Of the Earthquake felt at Boston in New-England, Nov. 18, 1755. Communicated by John Hyde, Esq. F.R.S.

TUESDAY, November 18, 1755, about half an hour past four in the morning, Mr. H. was awaked by the shaking of his bed and the house; the cause of which he immediately concluded could be nothing but an earthquake, having experienced one before. The trembling continued about two minutes. Near one hundred chimnies are levelled with the roofs of the houses; many more, probably not fewer than twelve or fifteen hundred, are shattered, and thrown down in part; so that in some places, especially on the low loose ground, made by encroachments on the harbour, the streets are almost covered with the bricks that have fallen. Some chimnies, though not thrown down, are dislocated or broken several feet from the top, and partly turned round as on a swivel; some are shoved on one side horizontally, jutting over, and just nodding to their fall; the gable ends of several brick buildings, perhaps twelve

or fifteen, are thrown down, and the roofs of some houses are quite broken in by the fall of the chimnies; some pumps suddenly dried up, the convulsions of the earth having choaked the springs that supplied them, or altered their course. Many clocks were also stopped by being so violently agitated.

SECTION XVI.

Of the Earthquake felt in New York, Nov. 18, 1755, in a Letter from Cadwallader Colden, Esq.

A FEW minutes past four in the morning, Mr. C. was awaked with the shock of the earthquake. He plainly heard the noise like that of carts on pavements, going to the eastward, with now and then a noise like the explosion of a great gun at a distance. It was felt about four o'clock at Philadelphia, and half after four at Boston, and was more violent to the eastward than the westward, and there was an eruption at a place called Scituate, about twenty or thirty miles to the southward of Boston. The summer and autumn had been unusually dry for some days before the earthquake, though the sky was perfectly calm and serene, the air was so light, that the smoke of the town by falling down was offensive to our eyes as we walked the streets. In the last remarkable earthquake, which happened about seventeen years before, and nearly at the same time of the year, the weather preceding it was much the same as now, attended with the falling of the smoke of the town.

SECTION XVII.

Of the Earthquake felt in Pennsylvania, Nov. 18, 1755, in a Letter to Mr. Peter Collinson, F.R.S.

ABOUT four o'clock this province was pretty generally alarmed with the shock of an earthquake. It gradually increased for one minute to such a degree as to open the chamber door, by drawing the bolt of the lock out of the staple. Some people thought they felt its continuance five or six minutes, but the writer thinks it did not exceed one, nor was it less. He felt the shock of the two earthquakes in England; but they were little in comparison to this.

[*Phil. Trans. abridged, Vol. X.*]

CHAP. XXI.

ACCOUNT OF THE PRECEDING EARTHQUAKE AS FELT IN THE LEAD MINES IN DERBYSHIRE.

We have purposely made this a separate chapter, as relating to a particular part of our own country, which to a certain extent on land, and, as will be perceived in the ensuing chapter, to a greater extent on water, was a common-sufferer.—*Editor*.

The following is an account of the earthquake, which happened at the lead mines on Eyam-edge in the peak of Derbyshire, on Saturday the 1st of November 1755, about eleven o'clock in the forenoon.

Francis Mason, the overseer, says, That he sat in a little room, about forty yards from the mouth of one of the engine shafts. He felt one shock, which very sensibly raised him up in his chair, and caused several pieces of lime or plaster to drop from the sides of the room. In a field about three hundred yards from the mines, there had happened a chasm or cleft on the surface of the earth, which was supposed to be made at the same time he felt the shock; its continuation from one end to the other, was near a hundred and fifty yards, being parallel to the range of the vein on the north side; the depth of it was about eight or nine inches, and its diameter four.

Two miners say, that at the aforesaid time they were employed in carting, or drawing along the drifts, the ore and other minerals to be raised up the shafts. The drift where they were working is about sixty fathoms, or a hundred and twenty yards deep, and the space of it from one end to the other upwards of fifty yards. They were suddenly surprised by a shock which greatly terrified them. They durst not attempt to climb the shaft, lest that should be running in on them, but consulted what means to take for their safety. While they were thinking of some place of refuge, they were alarmed

by a shock much more violent than the former; which put them in such a consternation, that they both ran precipitately to the other end of the drift. Soon after they were again alarmed by a third shock; which, after an interval of about four or five minutes, was succeeded by a fourth; and about the space of time after, by a fifth; none of which were so violent as the second. They heard after every shock a loud rumbling in the bowels of the earth, which continued for about half a minute, gradually decreasing, or appearing at a greater distance. They imagined, that the whole space of time, from the first shock to the last, was about twenty minutes. They remained about ten minutes in the mine after the last shock; when they thought it advisable to examine the passages, and to get out of the mine, if possible. As they went along the drifts, they observed, that several pieces of minerals had dropped from the sides and roof, but all the shafts remained entire, without the least discomposure. The space of ground at the mines, wherein it was felt, was nine hundred and sixty yards, being all that was at that time in work. [*Phil. Trans. Abr. Vol. X.*]

CHAP. XXII.

EXTRAORDINARY AGITATION OF THE WATERS IN VARIOUS PARTS OF OUR OWN AND FOREIGN COUNTRIES, BOTH INLAND AND MARITIME, ACCOMPANYING THE GENERAL EARTHQUAKE OF THE TWO PRECEDING CHAPTERS.

SECTION I.

At Portsmouth, in Hampshire. By Mr. John Robertson, F.R.S.

ON Saturday, November 1, 1755, about thirty-five minutes after ten in the morning, there was observed in the dock-yard at Portsmouth, an extraordinary motion of the waters in the north dock, and in the basin, and at two of the jetty-heads. In the north dock, whose length is about 229 feet, breadth 74 feet, and at that time about 17½ feet depth of water, shut in by a pair of strong

gates, well secured, his majesty's ship the Gosport of 40 guns, was just let in to be docked, and well stayed by guys and hawsers. On a sudden the ship ran backwards near three feet, and then forwards as much, and at the same time she alternately pitched with her stern and head to the depth of near three feet; and by the libration of the water, the gates alternately opened and shut, receding from each other near four inches.

In the basin, whose length is about 240 feet, breadth 220 feet, and at times about 17 feet depth of water, shut in by two pair of gates, lay the Berwick of 70 guns, the Dover of 40 guns, both in a direction nearly parallel to the Gosport; and a merchant ship of about 600 tons, unloading tar, lying in an oblique direction to the others. These ships were observed to be agitated in like manner with the Gosport, and the tar-ship to roll from side to side: the swell of the water against the sides of the basin was observed to be nine inches; one of the workmen measured it between the librations.

The Nassau, a 70 gun ship, lying along side a jetty head, between the north dock and the basin; also the Duke, a 90 gun ship, lying against the next jetty-head, to the southward, both in a direction nearly at right angles to the others, were observed to be rocked in the same manner, but not quite so violently: these two ships lay in the harbour. The dock and basin lie nearly east and west, on the west side of the harbour.

SECTION II.

In Sussex, and the Southern Parts of Surrey. By Philip Carteret Webb, Esq. F.R.S.

In his garden at Busbridge, near Godalmin in Surrey, on Saturday the first of November 1755, at half an hour after ten in the forenoon, Philip Smith, John Street, and John Johnson, the gardeners, were alarmed by a very unusual noise in the water, at the east end of the long canal, near which John Street and John Johnson were then at work. On looking that way, they observed the water, in that part of the canal, in great agitation, attended with a considerable noise. The water soon raised itself in a heap or ridge, extending lengthwise about thirty yards, and between two and three feet above the usual level of the water; after which the heap or ridge heeled or vibrated towards the north, or left side of the canal,

with great force, and flowed about eight feet over the grass walk on that side of the canal, quite up to the arch. On the water's returning back into the canal, it again raised itself into a heap or ridge in the middle; after which the heap or ridge heeled or vibrated with greater force towards the south, or right-hand side of the canal, and flowed over the grass-walk, and through the rustic arch on that side; and drove a small stream of water, which runs through it, thirty-six feet back upwards, towards its source. During this latter motion, the bottom of the canal, on the north side, for several feet in width, was quite bare of water. The water being returned into the canal, the vibrations became less and less, but so strong as to make the water flow several times over the south bank of the canal, which is not so high as the north bank. In about a quarter of an hour from the first appearance the water became quiet and smooth as before. The motion of the water was, during the whole time, attended with a great perturbation of the sand from the bottom of the canal, and with a great noise, likened by the gardeners to that of water turning a mill. During the whole time the weather was remarkably still, there not being the least wind; and there was no tremor or motion of the earth felt on the sides of the canal.

The canal is near seven hundred feet long from west to east, and is about fifty-eight wide: there is a small spring which constantly runs through it. The water at the east end, where this appearance was observed, usually pens from two to four feet, being gradually deeper to the west end, where it pens to about ten feet. No motion was taken notice of in the water at the west end of the canal, the first vibration, which drove the water over the grass-walks, was from south to north. The grass-walk on the north side of the east end of the canal is fourteen inches, and that on the south side about ten inches higher than the usual level of the water: the highest part of the walk, over which the water flowed, is about twenty inches above the water-level.

Mr. W. was informed, that the water was affected about the same time in the following places. In a mill-pond, at Medhurst in Sussex, the sudden agitation and swell of the water rolling toward the mill was so remarkable, that the miller imagined a sluice had been opened at the upper end of the pond, and had let a back-water into it; but on search it was found to be shut as usual. Below the mill the swell of water was so great, as to drive the stream upwards

back into the conduit of the mill. At Lee, in the parish of Witley, in Surrey, about five miles from Busbridge, between Busbridge and Medhurst; the water in a canal or pond belonging to Mr. Luff was so violently agitated, that the gardener, on the first appearance, ran for help, thinking a number of otters were under the water destroying the fish. In a mill-pond, near Guildford in Surrey, a like swell and agitation of the water was observed by several persons, one of whom stood all the time on a bridge of wood, over the pond. Not the least tremor or motion of the earth was felt in any of these places, or at the bridge at Guildford.

SECTION III.

In the Parish of Cobham. By Swithin Adee, of Guildford, M.D. F.R.S.

A MAN, in the parish of Cobham, was watering a horse in hand, at a pond close by the house, which is fed by springs, and had no current. The time he fixes was about ten in the morning, but their clock goes too slow. While the horse was drinking, the water ran away from the horse, and moved towards the south with swiftness, and in such a quantity, as left the bottom of the pond bare; then returned with such impetuosity, as made the man leap backwards, to secure himself from the sudden approach of the water. It went back again to the south, with a great swell, and returned again. On inspecting the place, Dr. A. found the water must have risen above one foot. The ducks were alarmed at the first agitation, and flew all instantly out of the pond. The man observed, that there was a particular calm at this time of day. It should be observed that there were two fluxes and two refluxes seen distinctly.

SECTION IV.

At Medhurst. By Mr. John Hodgson.

As to the ponds near Medhurst, every body agrees, that there was an extraordinary swelling of the water. The water was thrown several feet above its banks, both at North-mill, at South-pond, and the pond in Lord Montacute's park; and at the first of these, on its retreat, left some fishes on dry land.

SECTION V.

At Cranbrook, in Kent. By Wm. Tempest, Esq. F.R.S.

THE people here are very much alarmed on account of an earthquake, which happened last Saturday (November the 1st). I felt nothing of it, but some people fancied they did. I do not hear that the earth moved; only the waters of several ponds, in this and the adjacent parishes, were in such motion, that they overflowed their banks, then returned back, and overflowed the other side.

SECTION VI.

Near Tunbridge. By John Pringle, M.D. F.R.S.

THE pond at Eaton-bridge, near Tunbridge, is about an acre in size, and across it is a post and rail, which is almost quite covered by the water. Some people heard a noise in the water, and imagining something had tumbled in, ran to see what was the matter; when, to their surprise, they saw the water open in the middle, so as that they could see the post and rail a good way down, almost to the bottom, and the water dashing up over a bank about two feet high, and perpendicular to the pond. This it did several times, making a great noise. They did not feel the least motion on the shore, nor was there any wind, but a dead calm.

SECTION VII.

In the River Thames, near Rotherhithe. By Mr. Henry Mills.

BEING in one of his barges, unloading some timber, between eleven and twelve o'clock, he was surprised by a sudden heaving up of the barge from a swell of the water, not unlike what happens when a ship is launched from any of the the builders' yards in the neighbourhood. After the barge had alternately risen and sunk three or four times, with a motion gradually decreasing, the water became quiet again.

SECTION VIII.

In Peerless Pool, near Old-street, London. By Thos. Birch, D. D. Secretary to the Royal Society.

ON the reports, received from several gentlemen, that the agi-

tation of the waters observed in many parts of England, Scotland, Ireland, Holland, &c. on Saturday, November 1, 1755, had been likewise noticed in Peerless Pool, near Old-street road, being curious to have as authentic and circumstantial an account as possible of a fact, which he had not heard to have been remarked in any other part of London or its suburbs, Dr. B. went thither on Saturday, December 6, 1755, and took down the following particulars relating to it, from the mouth of one of the two waiters there, who were eye-witnesses of it. He being engaged between the hours of ten and eleven in the morning, with his fellow-waiter, in some business near the wall inclosing the ground, which contains the fish-pond, and accidentally casting his eye on the water, was surprised to see it greatly moved without the least apparent cause, as the air was quite calm. This occasioned him to call to his companion to take notice of it, who at first neglected it, till being urged to attend to so extraordinary an appearance, he was equally struck with the sight of it. Large waves rolled slowly to and from the bank near them, at the east end, for some time, and at last left the bed of the pond dry for several feet, and in their reflux overflowed the bank ten or twelve feet, as they did the opposite one, which was evident from the wetness of the ground about it. This motion having continued five or six minutes, the two waiters stepped to the cold bath, near the fish-pond, to see what passed there; but no motion was observed in it by them, or by a gentleman who had been in it, and was then dressing himself, and who, on being told of the agitation in the fish-pond, went directly thither, with the waiters, and was a third witness of it. On the ceasing of it, they all three went to the pleasure-bath, between which and the fish-pond, the cold-bath is situated; but they found the said pleasure-bath then motionless, but to have been agitated in the same manner with the fish-pond, the water having left plain marks of its having overflowed the banks, and risen to the bushes on their sides. The motion in the fish-pond had been also observed by some persons in a house belonging to Mr. Kemp, the master of Peerless Pool, situated at a small distance from that pond, and commanding a full view of it.

SECTION IX.

At Rochford, in Essex. By the Rev. Mr. Thomlinson.

At a pond in a close of Mr. Sly's, adjoining to the church-yard,

the water was observed to flow a considerable way up the mouth of the pond, and then returning, to flow up the opposite side, repeating this sort of motion for about a quarter of an hour. The motion of the water in the pond was only from east to west, and from west to east, alternately.

SECTION X.

In Berkshire, near Reading. By Mr. Richard Phillips.

On the 1st of November 1755, at about eleven o'clock in the morning, as Mr. Paunceforth's gardener was standing by a fish-pond in the garden, he felt a most violent* trembling of the earth, directly under his feet, which lasted upwards of fifty seconds; immediately after which he observed that the water in the pond was in a very unusual motion, and suddenly thrown on the opposite side, leaving that on which he stood quite dry, for the space of two yards, and continued in that state for about two minutes, when it returned as before, and collecting in or near the middle of the pond, rose about twenty inches above the level of the water on each side, and continued so for two minutes in violent agitation, which the gardener described to be like the boiling of a pot.

At the same time Captain Clarke, at Caversham, in Oxfordshire, a mile distant from Reading, was alarmed with a very great noise, as if part of the house had been falling down; on examination however it did not appear that the house was at all damaged; but a vine, which grew against it, was broken-off, and two dwarf trees, such as are used in espalier hedges, were split by the shock.

SECTION XI.

In Oxfordshire, at Shirburn Castle, the Seat of the Earl of Macclesfield, Pres. R. S. Communicated by his Son, the Lord Viscount Parker, F. R. S. then on the spot.

On Saturday, November 1, a little after ten o'clock in the fore-

* We have already noticed, from the same authentic journal, a similar tremour of the earth in another part of our native island, in the preceding chapter. The Editor of the original, unmindful of this last communication, has observed in a subjoined note to the present paragraph, as follows: "This is the only account that mentions any tremor of the earth to have accompanied the agitation of the waters in this island." Similar percussions were felt at Turin, and in the Tyrol.—*Editor.*

noon, walking in the garden at Shirburn Castle, he perceived the gardener, who was coming towards him by the end of the moat, on a sudden stop short, and look earnestly into the water. He went towards him, and perceived immediately a very strange motion in the water. There was a pretty thick fog, not a breath of air, and the surface of the water all over the moat was as smooth as a looking-glass; yet in that corner of the moat near which he stood, the water flowed into the shore, and retired again successively, in a surprising manner. The flux and reflux were quite regular. Every flood began gently; its velocity increased by degrees, till at last, with great impetuosity, it rushed in till it had reached its full height, at which it remained for a little while, and then again retired, at first gently ebbing, at last sinking away with such quickness, that it left a considerable quantity of water entangled among the pebbles, laid to defend the bank, which run thence in little streams over the shore, now deserted by the water, which at other times always covers it. As the slope of the sides of the moat is very gentle, the space left by the water at its reflux was considerable, though the difference between the highest flood and lowest ebb of these little tides, was but about four inches and a half perpendicular height; the whole body of water seemed to be violently thrown against the bank, and then retiring again, while the surface of the whole moat all the time continued quite smooth, without even the least wrinkle of a wave. He sent persons to several other ponds, in all which the agitation was very considerable. The swells, that succeeded each other, were not equal, nor did they increase or diminish gradually; for sometimes, after a very great swell, the next two or three would be small, and then again would come a very large one, followed by one or two more as large, and then less again.

SECTION XII.

In Devonshire and Cornwall, at Plymouth, Mounts-Bay, Penzance, &c. By John Huxham, M. D. F. R. S.

SATURDAY, November 1, about four P. M. we had (just about high water) an extraordinary boar, as the sailors call it. The sea seemed disturbed about twenty minutes before, though there was very little wind that day, or for some days before. One of our surgeons, who had then just crossed the ferry at Creston, a mile to the south-east of Plymouth, said, that the tide had made a very

extraordinary out (or recess) almost immediately after high-water (about four P. M.), left both the passage-boats, with some horses, and several persons, at once quite dry in the mud, though the minute or two before, in four or five feet water; in less than eight minutes the tide returned with the utmost rapidity, and floated both the boats again, so that they had near six feet water. The sea sunk and swelled, though in a much less degree, for near half an hour longer. It was said, that at the next morning's tide there were several very large surges. This boar drove several ships from their moorings, and broke some of the hawsers, and twirled the ships and vessels round in a very odd manner. At Crumill passage, over another arm of the sea, about two miles w[illegible] of Plymouth, the same phænomena were observed; and in [illegible]ouse lake, that communicates with that arm of the sea, th[illegible]ame in with such impetuosity, that it drove every thing before it, tearing up the mud, sand, and banks, in a very shocking manner, and broke a large cable, by which the foot passage-boat is drawn from side to side of the lake.

You will please to observe, that it happened not here till about four P. M.; at Portsmouth, about eleven A. M.; in Holland, about eleven A. M.; at Kinsale, &c. in Ireland not till three or four P. M.

SECTION XIII.

On the Coast of Cornwall. By the Rev. Wm. Borlase, of Ludgvan, A. M. F. R. S.

A little after two o'clock in the afternoon, about half an hour after ebb, the sea was observed at the Mount's-bay pier to advance suddenly from the eastward. It continued to swell and rise for the space of ten minutes; it then began to retire, running to the west and south-west, with a rapidity equal to that of a mill-stream descending to an undershot-wheel; it ran so for about ten minutes, till the water was six feet lower than when it began to retire. The sea then began to return, and in ten minutes it was at the beforementioned extraordinary height; in ten minutes more it was sunk as before; and so it continued alternately to rise and fall between five and six feet, in the same space of time. The first and second fluxes and refluxes were not so violent at the Mount pier as the third and fourth, when the sea was rapid beyond expression, and the alterations continued in their full fury for two hours; they then grew

fainter gradually, and the whole commotion ceased about low water, $5\frac{1}{2}$ hours after it began.

Penzance pier lies three miles west of the Mount, and the reflux was first observed there forty-five minutes after two; the influx came on from the south-east, and south-south-east. Here the greatest rise was eight feet, and the greatest violence of the agitation about three o'clock. Newlyn pier lies a mile west of Penzance. Here the flux was observed first, as at the Mount, and came in from the southward [the eastern current being quite spent] nearly at the same time as at the Mount and Penzance, but in a manner somewhat different; it came on like a surge, or high-crested wave, with a surprising nois[illegible]he first agitations were as violent as any; and after a few adva[illegible]d retreats at their greatest violence, in the same space of ti[illegible] the Mount, the sea became gradually quiet, after it had risen en feet perpendicular at least. This is near five feet more than at the Mount pier, and two feet more than at Penzance. The agitations of the sea at Mousehole, another pier in this bay, did not materially differ from those at Newlyn.

In the little harbour of Heyle, about four miles north of the Mount, on the Severn sea, the agitation did not make its appearance till an hour and a little more after the ebb began, which must be full an hour later than with us. In this inland half-tide harbour it continued visible but an hour and half; the greatest flux was about the middle of that time, the surge being at that time seven feet high; but in general it rose and fell but two feet only, owing probably to the force and quantity of water being broken in its advances into so retired a creek. At Swansea, in Wales, farther up in St. George's channel where their ebb is later still than at Heyle, the agitation was proportionably later, and was not observed till after two hours ebb, near three-quarters after six. At Kingsale, in Ireland, more indeed to the north of us, but more open to the Atlantic ocean than Swansea, and farther to the west, the agitation reached not a full hour after us, but above two hours sooner than at Swansea; all tending to shew, that the force came from the south and southwest.

What relations these little palpitations, or tremulous rebounds of the sea, had to the dreadful convulsions on the coasts of Spain and Portugal, whether they were the fainter parts of that deplorable shock at Lisbon, or the expiring efforts of some similar subterraneous strugglings of nature farther to the west, under the Atlantic

ocean, will remain uncertain, till more facts and dates appear; but by the accounts from abroad, this first of November seems to have been a day of universal tremor to all the sea-coasts of the western parts of Europe.

I would not be thought to suggest, sir, that a shock so far off as the coast of Spain could be so immense, as to propogate a motion of the water quite home to our shores. I should rather imagine, that there were several shocks, and some much nearer to us, but all perhaps from one and the same cause diffused in different portions, and permeating more contracted or dilated, but still communicating passages; I should imagine that this cause affected the seas and land, in proportion to its own force, and the [illegible]r or weaker resistence of the incumbent pressure; that wh[illegible]und the least resistance of all, there it found its vent, [illegible] its cure.

Many other similar accounts were a[illegible]observed both in the sea and inland lakes: as at Swa[illegible] coasts of Norfolk and Lincolnshire, &c.; the lakes [illegible]d; a pond near Durham, at half past ten o'clock; at Loch Ne[illegible]h Lomond, &c. in the north of Scotland, about ten o'clock.

It appears also by communications sent from abroad, that the like agitations of the water were observed at the Hague, Leyden, Harlem, Amsterdam, Utrecht, Gouda, and Rotterdam, and also at Bois-le Duc; about eleven o'clock on the first of November; and likewise at Kingsale and Cork, in Ireland, between two and three o'clock.

SECTION XIV.

Of an Extraordinary Alteration in the Baths of Toplitz, in Bohemia, on the 1*st of Nov.* 1755. *By Father Joseph Steplin, of Prague.*

A report being brought that at Toplitz, a village famous for its baths, and nine Bohemian miles north-west from Prague, the source of these baths had undergone some change, in order to know the truth of this, Father Steplin requested the President of the Supreme Royal Council to send him an exact account of it, in answer to the several questions which he proposed to him. By this means he procured the following: that in the year 762 those baths were discovered; from which time the principal spring had constantly thrown out the hot waters in the same quantity, and of the same quality.

On the 1st of November, 1755, between eleven and twelve in the morning, the chief spring cast forth such a quantity of water, that in the space of half an hour all the baths ran over. About half an hour before this vast increase of the water, the spring became turbid, and flowed muddy; and having stopped entirely near a minute, broke forth again with prodigious violence, driving before it a considerable quantity of a reddish oker, crocus martialis. After which it became clear, and flowed as pure as before; and continues still to do so; but it supplies more water than usual, and that hotter, and more impregnated with its medicinal quality.

SECTION XV.

Concern[illegible] Agitation of the Waters, Nov. 1. 1755. [illegible] De Hondt, of the Hague.

We had at el[illegible] phenomenon, which astonished every body. In absolu[illegible] weather there was observed of a sudden so violent a motio[illegible] that the ships were struck against each other, and [illegible] which fastened them. It was felt at the sa[illegible] at the Hague, Leyden, Harlem, Amsterdam, Gouda, Utrecht, Rotterdam, and Bois-le-Duc. At the Hague, it was but slight; and no motion was felt in the ground.

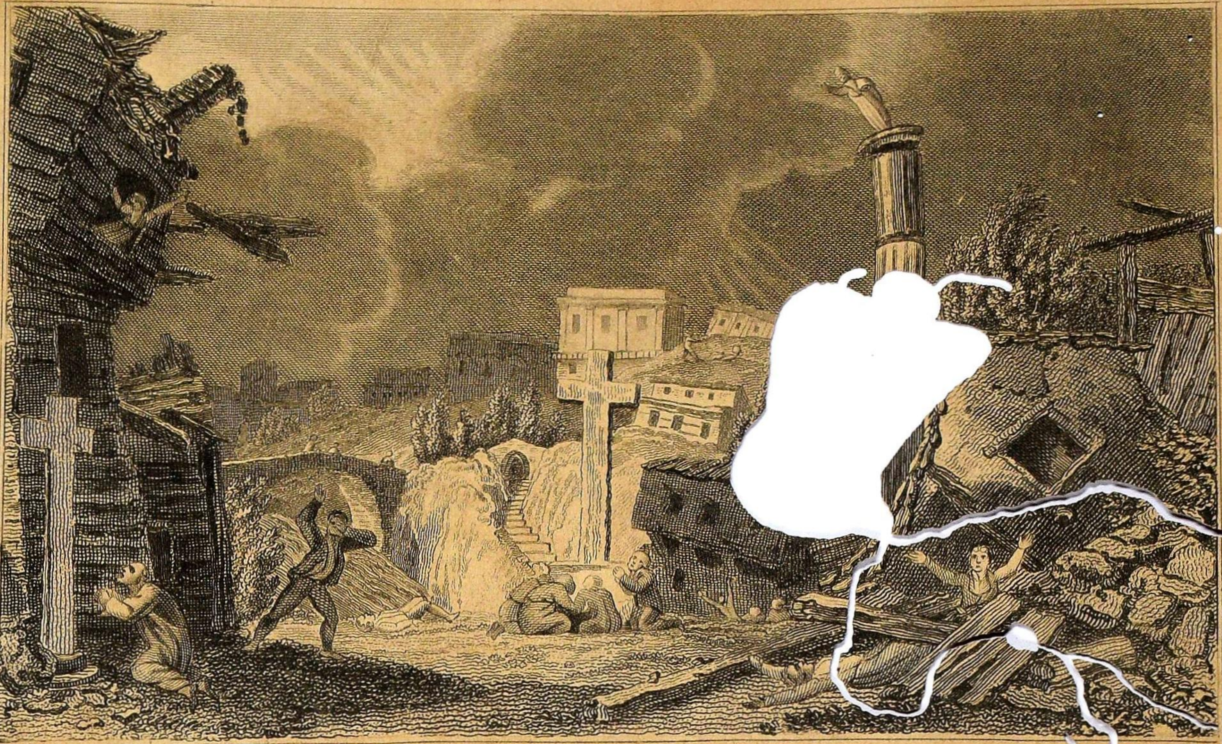
SECTION XVI.

On the same. By M. Allamond, Professor of Philosophy at Leyden, and F. R. S.

Between half an hour after ten and eleven in the morning, in some of the canals of this city, the water rose suddenly on the quay, situated on the south. It returned afterwards to its bed, and made several very sensible undulations, so that the boats were strongly agitated. The same kind of motion was perceived here in the tuns of water of two brewhouses, and in those of three brewhouses at Harlem. The branches of the Roman Catholic church at Rotterdam, which hung from long iron rods, made several oscillations. A tallow-chandler at the Hague was surprised to hear the clashing noise made by all the candles hung up in his shop.

The accounts brought from Norway inform us, that the same observations were made there, almost at the same time.

[*Phil. Trans. Abridged, Vol. X.* 1755.]



Engraved by Berry from a Drawing by Craig | *For the Gallery of Nature & Art*

COMMENCEMENT OF THE EARTHQUAKE AT MESSINA.

London, Published by R. Wilks, 89 Chancery Lane, Feb. 1. 1814.

CHAP. XXIII.

EARTHQUAKE AT MESSINA, AND THE ADJOINING COUNTRY, AND DESTRUCTION OF THE CITY IN 1783.

[By Sir William Hamilton.]

Sir William Hamilton, in the d[illegible]us, gives, as he says, some little idea of [illegible], and of the various phænomena exhibit[illegible] (which began the 5th of February, 1783, [illegible] to the day he was writing, viz. May 23) in [illegible] Messina, and in the parts of Sicily nearest to th[illegible]ent. From the most authentic reports, and accounts received at the offices of his Sicilian Majesty's secretary of state, he gathered in general, that the part of Calabria, which has been most affected by this heavy calamity, is that which is comprehended between the 38th and 39th degree of latitude, being the foot or extreme point of the continent: that the greatest force of the earthquakes seemed to have exerted itself from the foot of those mountains of the Apennines called the Monte Deio, Monte Sacro, and Monte Caulone, extending westward to the Tyrrene sea; that the towns, villages, and farm-houses, nearest these mountains, situated either on hills or in the plain, were totally ruined by the first shock of the 5th of February about noon; and that the greatest mortality was there; that in proportion as the towns and villages were at a greater distance from this centre, the damage they received was less considerable; but that even those more distant towns had been greatly damaged by the subsequent shocks of the earthquake, and especially by those of the 7th, the 26th, and 28th of February, and that of the 1st of March; that from the first shock, the 5th of February, the earth continued to be in a continual tremour, more or less; and that the shocks were more sensibly felt at times in some parts of the afflicted provinces than in others; that the motion of the earth had been various, and, according to the

Italian denomination, vorticoso, orizontale, and oscillatorio, that is, either whirling like a vortex, horizontal, or by pulsations, or beatings from the bottom upward; that this variety of motion had increased the apprehensions of the unfortunate inhabitants of those parts, who expected every moment that the earth would open under their feet, and swallow them up; that the rains had been continual and violent, often accompanied with lightning and irregular and furious gusts of wind; that from all these causes the face of the earth of that part of Calabria above-mentioned was entirely altered, particularly on the westw[illegible] side of the mountains above named; that many openings [illegible] had been made in those parts; that some hills had been l[illegible]rs quite levelled; that in the plains, deep chasms ha[illegible] many roads were rendered impassable; th[illegible]n split asunder, and parts of them driven [illegible]e; that deep vallies had been filled up by t[illegible]rmed those vallies, having been detached by the violence [illegible] earthquakes, and joined together; that the course of some rivers had been altered; that many springs of water had appeared in places that were perfectly dry before; and that in other parts, springs that had been constant had totally disappeared; that near Laureano in Calabria Ultra, a singular phenomenon had been produced, that the surface of two whole tenements or tracts of land, with large olive and mulberry-trees on them, situated in a valley perfectly level, had been detached by the earthquake, and transplanted, the trees still remaining in their places, to the distance of about a mile from their first situations; and that from the spot on which they formerly stood hot water had sprung up to a considerable height, mixed with sand of a ferruginous nature; that near this place also some countrymen and shepherds had been swallowed up with their teams of oxen and their flocks of goats and sheep; in short, that beginning from the city of Amantea, situated on the coast of the Tyrrene sea in Calabria Citra, and going along the westward coast to Cape Spartivento in Calabria Ultra, and then up the eastern coast as far the Cape d'Alice (a part of Calabria Citra on the Ionian sea), there is not a town or village, either on the coast or inland, but what is either totally destroyed, or has suffered more or less, amounting in all to near four hundred, what are called there paeses. A village containing less than one hundred inhabitants is not counted as a paese.

The greatest mortality fell upon those towns and countries situated in the plain on the western side of the mountains Dejo, Sacro, and Caulone. At Casal Nuovo, the Princess Gerace, and upwards of 4000 of the inhabitants lost their lives; at Bagnara, the number of dead amounts to 3017; Radicina and Palmi count their loss at about 3000 each; Terranuova about 1400; Seminari still more. The sum total of the mortality in both Calabrias and in Sicily, by the earthquakes alone, according to the returns in the secretary of state's office at Naples, is 32,367; but there was good reason to believe that, including strangers, the number of lives lost must have been considerably greater, 40,000 at least may be allowed, and Sir Wm. believed, without any exaggeration. From the same office it was stated that the inhabitants of Scilla, on the first shock of the earthquake, the 5th of February, had escaped from their houses on the rock, and, following the example of their prince, taken shelter on the sea-shore; but that in the night-time the same shock, which had raised and agitated the sea so violently, and done so much damage on the point of the Faro of Messina, had acted with still greater violence there, for that the wave (which was falsely represented to have been boiling hot, and that many people had been scalded by its rising to a great height) went furiously three miles inland, and swept off in its return 2473 of the inhabitants of Scilla, with the prince at their head, who were at that time either on the Scilla strand, or in boats near the shore.

All accounts agreed, that of the number of shocks which have been felt since the beginning of this formidable earthquake, amounting to some hundreds, the most violent, and of the longest duration, were those of the 5th of February, at $19\frac{1}{2}$ (according to the Italian way of counting the hours); of the 6th of February, at 7 hours in the night; of the 27th of February, at $11\frac{1}{4}$ in the morning; of the 1st of March at $8\frac{1}{2}$ in the night; and that of the 28th of March, at $1\frac{1}{2}$ in the night. It was this last shock that affected most the upper part of Calabria Ultra, and the lower part of the Citra, an authentic description of which may be seen in a letter received from the Marquis Ippolito, an accurate observer residing at Catanzaro in the Upper Calabria. The first and the last shocks must have been tremendous indeed, and only these two were sensibly felt in the capital, Naples.

The accounts which this government has received from the province of Cosenza, are less melancholy than those from the province of Calabria Ultra. From Cape Suvero to the Cape of Cetraro on

the western coast, the inland countries, as well as those on the coast, are said to have suffered more or less in proportion to their proximity to the supposed centre of the earthquakes; and it has been constantly observed, that its greatest violence has been exerted, and still continued to be so, on the western side of the Apennines, precisely the celebrated Sila of the ancient Brutii, and that all those countries situated to the eastward of the Sila had felt the shocks of the earthquake, but without having received any damage from them. In the province of Cosenza there do not appear to be above 100 lives lost. In the last account from the most afflicted part of Calabria Ultra, two singular phænomena are mentioned. At about the distance of three miles from the ruined city of Oppido, there was a hill, the soil of which is a sandy clay, about 500 palms high, and 1300 in circumference at its basis. It was said that this hill, by the shock of the 5th of February, was carried to the distance of about four miles from the spot where it stood, into a plain called the Campo di Bassano. At the same time the hill on which the town of Oppido stood, which extended about three miles, divided in two, and as its situation was between two rivers, its ruins filled up the valley, and stopped the course of those rivers, two great lakes are already formed, and are daily increasing, which lakes, if means are not found to drain them, and give the rivers their due course, in a short time must greatly infect the air.

From Sicily the accounts of the most serious nature were, those of the destruction of the greatest part of the noble city of Messina, by the shock of the 5th of February, and of the remaining parts by the subsequent ones;—that the quay in the port had sunk considerably, and was in some places a palm and a half under water;—that the superb building, called the Palazzata, which gave the port a more magnificent appearance than any port in Europe can boast of, had been entirely ruined;—that the Lazaret had been greatly damaged; but that the citadel had suffered little;—that the mother church had fallen; in short, that Messina was half destroyed;—that the tower at the point of the entrance of Faro was half detroyed;—and that the same wave, that had done such mischief at Scilla, had passed over the point of land at the Faro, and carried off about twenty-four people. The viceroy of Sicily likewise gave an account of some damage done by the earthquakes, but nothing considerable, at Melazzo, Patti, Terra di Santa Lucia, Castro Reale, and in the island of Lipari.

Such was the intelligence Sir William was possessed of by those reports; but as he was particularly curious on the subject of volcanoes, and was persuaded in his own mind, from the earthquakes being confined to one spot, that some great chemical operation of nature, of the volcanic sort, was the real cause of them; in order to clear up many points, and to come at truth, he took the sudden resolution to employ about twenty days in making the tour of such parts of Calabria Ultra and Sicily as had been, and were still, most affected by the earthquakes, and examining with his own eyes the phænomena abovementioned. He accordingly hired for that purpose a Maltese speronara for himself, and a Neapolitan felucca for his servants: leaving Naples the 2d of May, he sailed round the coasts of the Calabrias, that had been afflicted with this grievous misfortune; occasionally landing in different parts, and making incursions inland, to learn by his own eyes and ears, some particulars of such mighty mischiefs: by which means the foregoing general accounts were mostly confirmed, with some slight variations, and many curious particular circumstances. At most places he perceived ruined houses and towns, and that most of the inhabitants were in barracks, which are just such sort of buildings as the booths of our country fairs, though indeed many as he had seen were more like our pig-sties. In several of the parts, from the barracks having been ill-constructed, and many of them situated in a very unwholesome spot, an epidemical disorder had taken place, and carried off many, and was still in fatal force while he was there. And he feared, as the heats should increase, the same misfortune would attend most parts of the unfortunate Calabria, as also the city of Messina. All reports agreed, that every shock of the earthquake seemed to come with a rumbling noise from the westward, beginning usually with the horizontal motion, and ending with the verticose, which is the motion that has ruined most of the buildings in this province. He found it a general observation also, that before a shock of an earthquake, the clouds seemed to be fixed and motionless; and that immediately after a heavy shower of rain, a shock quickly followed. He spoke with many who were thrown down by the violence of some of the shocks; and several peasants in the country said that the motion of the earth was so violent, that the heads of the largest trees almost touched the ground from side to side; that during a shock, oxen and horses extended their legs wide asunder not to be thrown down, and that they gave evident

signs of being sensible of the approach of each shock. Sir William himself observed, that in the parts that have suffered most by the earthquakes, the braying of an ass, the neighing of a horse, or the cackling of a goose, always drove people out of their barracks, and was the occasion of many paternosters and avemarias being repeated, in expectation of a shock. From Monteleone he descended into the plain, having passed through many towns and villages which had been more or less ruined according to their vicinity to the plain. The town of Mileto, situated in a bottom, he saw was totally destroyed, and not a house standing. Here, as well as in several other parts, he mentions most remarkable instances of animals being able to live long without food, of which there have been many examples during these present earthquakes. At Soriano two fattened hogs, that had remained buried under a heap of ruins, were taken out alive the forty-second day; they were lean and weak, but soon recovered. It was evident to his observation, that all habitations situated on high grounds, the soil of which is a gritty sand-stone, somewhat like a granite, but without the consistence had suffered less than those situated in the plain, which are universally levelled to the ground. The soil of the plain is a sandy clay, white, red, or brown; but the white prevails most, and is full of marine shells, particularly scollop shells. He was told that, during the earthquake of the 5th of February, from several hollow spots a fountain of water mixed with sand had been driven to a considerable height. Sir William spoke to a peasant here, who was present, and was covered with the water and sand; but assured him, that it was not hot, as had been represented. Before this appearance, he said, the river was dry; but soon after returned, and overflowed its banks. Sir William afterwards found, that the same phenomenon had been constant with respect to all the other rivers in the plain during the formidable shock of the 5th of February. He thinks this phenomenon is easily explained, by supposing the first impulse of the earthquake to have come from the bottom upwards, which all the inhabitants of the plains attest to be fact; the surface of the plain suddenly rising, the rivers, which are not deep, would naturally disappear, and the plain, returning with violence to its former level, the rivers must naturally have returned and overflowed, at the same time that the sudden depression of the boggy grounds would as naturally force out the water that lay hid under their surface. He observed in the other parts, where this sort of phenomenon had been

exhibited, that the ground was always low and rushy. It had been remarked at Rosarno, and the same remark had been constantly repeated to him in every ruined town that he visited, that the male dead were generally found under the ruins in the attitude of struggling against the danger; but that the female attitude was usually with hands clasped over their heads, as giving themselves up to despair, unless they had children near them; in which case they were always found clasping the children in their arms, or in some attitude which indicated their anxious care to protect them: a strong instance of the maternal tenderness of the sex!

Speaking of the two tenements, called the Macini and Vaticano, which are said to have changed their situation by the earthquake; Sir W. says, the fact is true, and easily to be accounted for. These tenements were situated in a valley surrounded by high grounds and the surface of the earth, which has been removed, had been probably long undermined by little rivulets, which come from the mountains, and now are in full view on the bare spot the tenements had deserted. These rivulets have a sufficiently rapid course down the valley, to prove its not being a perfect level as was represented. I suppose the earthquake to have opened some depositions of rain-water in the clay-hills which surround the valley, which water, mixed with the loose soil, taking its course suddenly through the undermined surface, *lifting* it up with the large olive and mulberry-trees, and a thatched cottage, floated the entire piece of ground, with all its vegetation, about a mile down the valley, where it now stands, with most of the trees erect. These two tenements may be about a mile long, and half a mile broad. I was shewn several deep cracks in this neighbourhood, not one above a foot in breadth; but which, I was credibly assured, had opened wide during the earthquake, and swallowed up an ox, and near a hundred goats, but no countrymen as was reported. In the valley abovementioned I saw the same sort of hollows in the form of inverted cones, out of which, I was assured, that hot water and sand had been emitted with violence during the earthquakes as at Rosarno; but I could not find any one who could positively affirm that the water had been really hot, though the reports which government received affirm it. Some of the sand thrown out here with the water has a ferruginous appearance, and seems to have been acted on by fire.

From hence I went through the same delightful country to the town of Polistene. To pass through so rich a country, and not see a single house standing on it, is most melancholy indeed; wherever a house stood, there you see a heap of ruins, and a poor barrack, with two or three miserable mourning figures sitting at the door, and here and there a maimed man, woman, or child, crawling on crutches. Instead of a town, you see a confused heap of ruins, and round about them numbers of poor huts or barracks, and a larger one to serve as a church, with the church bells hanging on a sort of low gibbet; every inhabitant with a doleful countenance, and wearing some token of having lost a parent.

I travelled four days in the plain, in the midst of such misery as cannot be described. The force of the earthquake was so great there, that all the inhabitants of the towns were buried either alive or dead under the ruins of their houses in an instant. The town of Polistene was large, but ill situated between two rivers, subject to overflow. Two thousand one hundred, out of about six thousand, lost their lives here the fatal 5th of February. There was a nunnery at Polistene; being curious to see the nuns that had escaped, I asked the marquis, the baron of this country, to shew me their barracks; but it seems only one out of twenty-three had been dug out of her cell alive, and she was fourscore years of age. What causes a confusion in all the accounts of the phænomena produced by this earthquake in the plain, is the not having sufficiently explained the nature of the soil and situation. They tell you, that a town has been thrown a mile from the place where it stood, without mentioning a word of a ravine; that woods and corn-fields had been removed in the same manner, when in truth it is only on a large scale, what we see every day on a smaller, when pieces of the sides of hollow ways, having been undermined by rain waters, are detached into the bottom by their own weight. Here, from the great depth of the ravine, and the violent motion of the earth, two huge portions of the earth, on which a great part of the town stood, consisting of some hundreds of houses, were detached into the ravine, and nearly across it, about half a mile from the place where they stood; and what is most extraordinary, several of the inhabitants of those houses, who had taken this singular leap in them, were yet dug out alive, and some unhurt. I spoke to one myself who had taken this extraordinary journey in his house, with his wife and a maid servant:

neither he nor his maid-servant were hurt; but he told me his wife had been a little hurt, but was now nearly recovered. I happened to ask him, what hurt his wife had received? His answer, though of a very serious nature, was ludicrous enough. He said, she had both her legs and one arm broken, and that she had a fracture on her skull so that the brain was visible. It appears to me that the Calabresi have more firmness than the Neapolitans; and they really seem to bear their excessive present misfortune with a true philosophic patience. Of sixteen hundred inhabitants at Terra Nuova, only four hundred escaped alive. In other parts of the plain situated near the ravine, and near the town of Terra Nuova, I saw many acres of land with trees and corn-fields that had been detached into the ravine, and often without having been overturned, so that the trees and crops were growing as well as if they had been planted there. Other such pieces were lying in the bottom, in an inclined situation; and others again that had been quite overturned. In one place, two of these immense pieces of land having been detached opposite to each other, had filled the valley, and stopped the course of the river, the waters of which were forming a great lake: and this is the true state of what the accounts mention of mountains that had walked and joined together, stopping the course of the river, and forming a lake. At the moment of the earthquake the river disappeared, as at Rosarno, and returning soon after, overflowed the bottom of the ravine about three feet in depth, so that the poor people that had been thrown with their houses into the ravine from the top of it, and had escaped with broken bones, were now in danger of being drowned. Having walked over the ruins of Oppido, I descended into the ravine, and examined carefully the whole of it. Here I saw indeed the wonderful force of the earthquake, which has produced exactly the same effects as in the ravine of Terra Nuova, but on a scale infinitely greater. The enormous masses of the plain, detached from each side of the ravine, lie sometimes in confused heaps, forming real mountains, and having stopped the course of two rivers, great lakes are already formed, and, if not assisted by nature or art, so as to give the rivers their due course, must infallibly be the cause of a general infection in the neighbourhood. Sometimes I met with a detached piece of the surface of the plain, of many acres in extent, with the large oaks and olive-trees, with lupins or corn under them, growing as well, and in as good order at the

bottom of the ravine, as their companions, from whom they were separated, do on their native soil in the plain, at least five hundred feet higher, and at the distance of about three quarters of a mile. I met with whole vineyards in the same order in the bottom, that had likewise taken the same journey. In another part of the bottom of the ravine there is a mountain composed of the clay soil, and which was probably a piece of the plain detached by an earthquake at some former period; it is about two hundred and fifty feet high, and about four hundred feet diameter at its basis: this mountain, as is well attested, has travelled down the ravine near four miles, having been put in motion by the earthquake of the 5th of February. The abunbance of rain which fell at that time, the great weight of the fresh detached pieces of the plain, which are heaped up at the back of it, the nature of the soil of which it is composed, and particularly its situation on a declivity, accounts well for this phenomenon. The Prince of Cariati shewed me two girls, one of about sixteen years of age, who had remained eleven days without food under the ruins of a house at Oppido: she had a child of five or six months old in her arms, which died the fourth day. The girl gave a clear account of her sufferings; having light through a small opening, she had kept an exact account of the number of days she had been buried. She did not seem to be in bad health, drank freely, but had yet a difficulty in swallowing any thing solid. The other girl was about eleven years of age; she remained under the ruins six days only; but in so very confined and distressful a posture, that one of her hands, pressing against her cheek, had nearly worn a hole through it.

Several fishermen assured me, that during the earthquake of the 5th of February, at night, the sand near the sea was hot, and that they saw fire issue from the earth in many parts. This circumstance has been often repeated to me in the plain; and my idea is, that the exhalations which issued during the violent commotions of the earth were full of electrical fire, just as the smoke of volcanoes is constantly observed to be during violent eruptions; for I saw no mark, in any part of my journey, of any volcanic matter having issued from the fissures of the earth; and I am convinced, that the whole damage has been done by exhalations and vapours only. I was assured here, where they have had such a long experience of earthquakes, that all animals and birds are in a greater or less degree much more sensible of an approaching shock of an earthquake

than any human being; but that geese, above all, seem to be the soonest and most alarmed at the approach of a shock: if in the water, they quit it immediately, and there is no driving them into the water for some time after. The port of Messina and the town, in its half ruined state, by moon-light, was strikingly picturesque. Certain it is, that the force of the earthquake, though very violent, was nothing at Messina and Reggio, to what it was in the plain. I visited the town of Messina the next morning and found that all the beautiful front of what is called the Palazatta, which extended in very lofty uniform buildings, in the shape of a crescent, had been in some parts totally ruined, in others less; and that there were cracks in the earth of the quay, a part of which had sunk above a foot below the level of the sea. There cracks were probably occasioned by the horizontal motion of the earth in the same manner as the pieces of the plain were detached into the ravines at Oppido and Terra Nuova; for the sea at the edge of the quay is so very deep, that the largest ships can lie along-side; consequently the earth, in its violent commotion wanting support on the side next the sea, began to crack and separate. and as where there is one crack there are generally others less considerable in parallel lines to the first, I suppose the great damage done to the houses nearest the quay has been owing to such cracks under their foundation.

The mortality at Messina does not exceed seven hundred out of thirty thousand, the supposed population of this city at the time of the first earthquake. The generality of the inhabitants are in tents and barracks, which, having been placed in three or four different quarters, in fields and open spots near the town, but at a great distance from each other, must be very inconvenient for a mercantile town; and unless great care is taken to keep the streets of the barracks, and the barracks themselves clean, I fear that the unfortunate Messina will be doomed to suffer a fresh calamity from epidemical disorders, during the heat of summer. Indeed, many parts of the plain of Calabria seem to be in the same alarming situation, particularly owing to the lakes, which are forming from the course of rivers having been stopped, some of which were already green, and tending to putrefaction. Out of the cracks on the quay, it is said, that during the earthquakes fire had been seen to issue; but there are no visible sgns of it, and I am persuaded it was no more than, as in Calabria, a vapour charged with electrical fire, or a kind

of inflammable air. A curious circumstance happened here also, to prove that animals can remain long alive without food. Two mules belonging to the Duke of Belviso remained under a heap of ruins, one of them twenty-two, and the other twenty-three days: they would not eat for some days, but drank water plentifully, and were quite recovered. There are numberless instances of dogs remaining many days in the same situation; and a hen, belonging to the British vice-consul at Messina, that had been closely shut up under the ruins of his house, was taken out the twenty-second day, and was recovered: it did not eat for some days, but drank freely; it was emaciated, and shewed little signs of life at first. From these instances, and from those related before, of the girls at Oppido, and the hogs at Soriano, and from several others of the same kind, we may conclude, that long fasting is always attended with great thirst, and total loss of appetite. From every inquiry I found that the great shock of the th of February was from the bottom upwards, and not like the subsequent ones, which in general have been horizontal and vorticose. A circumstance worth remarking, and which was the same on the whole coast of the part of Calabria that had been most affected by the earthquake, is, that a small fish called cicirelli, resembling what we call in England white-bait, but of a greater size, and which usually lie at the bottom of the sea, buried in the sand, have been ever since the commencement of the earthquakes, and continue still to be, taken near the surface, and in such abundance, as to be the common food of the poorest sort of people; whereas, before the earthquakes, this fish was rare, and reckoned among the greatest delicacies. All fish, in general, have been taken in greater abundance, and with much greater facility, in those parts since they have been afflicted by earthquakes than before. I constantly asked every fisherman I met with on the coast of Sicily and Calabria, if this circumstance was true; and was as constantly answered in the affirmative; but with such emphasis, that it must have been very extraordinary. I suppose, that either the sand at the bottom of the sea may have been heated by the volcanic fire under it; or that the continual tremor of the earth has driven the fish out of their strong holds, just as an angler, when he wants a bait, obliges the worms to come out of the turf on a river side, by trampling on it with his feet, which motion never fails in its effect, as I have experienced very often myself. The officer who commanded in the citadel, and

who was there during the earthquake, assured me, that on the fatal 5th of February, and the three following days, the sea, about a quarter of a mile from that fortress, rose and boiled in a most extraordinary manner, and with a most horrid and alarming noise, the water in the other parts of the Faro being perfectly calm. This seems to point out exhalations or eruptions from cracks at the bottom of the sea, which may very probably have happened during the violence of the earthquakes; all of which, I am convinced, have here a volcanic origin. I perfectly understood the nature of the formidable wave that was said to have been boiling hot, and had certainly proved fatal to the baron of the country, the Prince of Scilla, who was swept off the shore into the sea by this wave, with two thousand four hundred and seventy-three of his unfortunate subjects. The following is the fact. The Prince of Scilla having remarked, that during the first horrid shock, which happened about noon the 5th of February, part of a rock near Scilla had been detached into the sea, and fearing that the rock of Scilla, on which his castle and town is situated, might also be detached, thought it safer to prepare boats, and retire to a little port or beach surrounded by rocks at the foot of the rock. The second shock of the earthquake, after midnight, detached a whole mountain, much higher than that of Scilla, partly calcareous, and partly cretaceous, situated between the Torre del Cavallo and the rock of Scilla. This having fallen with violence into the sea, at that time perfectly calm, raised the fatal wave, which broke with so much fury on the neck of land called the Punta del Faro, in the island of Sicily, and returning with great noise and celerity directly on the beach, where the prince and the unfortunate inhabitants of Scilla had taken refuge, either dashed them with their boats and richest effects against the rocks, or whirled them into the sea; those who had escaped the first and greatest wave were carried off by a second and third, which were less considerable, and immediately followed the first.

To conclude: the idea I have of the present local earthquakes is, that they have been caused by the same kind of matter that gave birth to the Æolian or Lipari islands; that perhaps an opening may have been made at the bottom of the sea, and most probably between Stromboli and Calabria Ultra, for from that quarter all agree, that the subterraneous noises seem to have proceeded; and that the foundation of a new island or volcano may have been laid, though

it may be ages, which to nature are but moments, before it is completed, and appears above the surface of the sea. Nature is ever active; but her actions are, in general, carried on so very slowly, as scarcely to be perceived by mortal eye, or recorded in the very short space of what we call history, let it be ever so ancient. Perhaps too, the whole destruction I have been describing may have proceeded simply from the exhalations of confined vapours, generated by the fermentation of such minerals as produce volcanoes, which have escaped where they meet with the least resistance, and must naturally in a greater degree have affected the plain, than the high and more solid grounds around it.

[*Phil. Trans.* 1783.]

CHAP. XXIV.

EARTHQUAKE IN CALABRIA IN THE YEAR 1783.

[By Count FRANCESCO IPPOLITO.]

CALABRIA has been at all times exposed to the terrible convulsions, of which we are at present the victims. The earthquakes in 1638 and 1659, by which the two provinces of Calabria were almost utterly destroyed, are fresh in every one's memory, as well as that of the year 1743-4, which afflicted us for a longtime, but without loss of cities or of men. Reggio, and the countries near it, are exposed to earthquakes almost every year, and if we look back to the highest antiquity, we shall find that all Italy, but particularly this country, and more particularly still the provinces we inhabit, have been subject to various catastrophes in consequence of volcanoes and subterraneous fires. But among so many earthquakes to which we have been exposed, not the least is that under which we at present suffer, whether we consider the force of the concussions, or their duration, or the changes that have taken place in the surface of the earth, or the ruin of so many cities and villages, with the loss of forty thousand inhabitants.

From the 5th of February to this instant the shocks have been more frequent, and almost every day repeated. At times the earth shook as it usually does on these occasions; but at others the motion

was undulatory, and at others vorticose, during which state it resembled a ship tossed about in a high sea. The most considerable of these repeated earthquakes were those which took place Feb. 5, 7, and 28; and finally on the 28th of March. These four eruptions coming, as nearly as we can judge by the phænomena and effects, from the chain of mountains which extend from Reggio hitherwards, have produced four different explosions in four different parts of Calabria. These explosions have produced various great effects; ruined cities and villages, levelled mountains, formed immense breaks in the earth, new collections of waters, old rivulets sunk in the earth and dispersed, rivers stopped in their course, soils levelled, small mountains which existed not before formed, plants rooted up, and carried to considerable distances from their first site, large portions of earth rolling about through considerable districts, animals and men swallowed up by the earth.

But I will confine myself to a short narrative of the effects of the last explosion of the 28th of March, which doubtless must have arisen from an internal fire in the bowels of the earth in these parts, as it took place precisely in the mountains which cross the neck of our peninsula which is formed by the two rivers, the Lameto which runs into the gulph of St. Euphemia, and the Corace, which runs into the Ionian sea, and properly into the bay of Squillace. That the thing was so, is evident from all the phænomena. This shock, like all the rest, came to us in the direction of the S. W. At first the earth began to undulate, then it shook, and finally it moved in a vorticose direction, so that many persons were not able to stand on their feet. This terrible concussion lasted about ten seconds; it was succeeded by others which were less strong, of less duration, and only undulatory; so that, during the whole night, and for half the next day, the earth was continually shaken, at first every five minutes, afterwards every quarter of an hour.

A terrible groan from under ground preceded this convulsion, lasted as long as it did, and finally ended with a loud noise, like the thunder of a mine that takes effect. These mighty thunderings accompanied not only the shocks of that night, and of the succeeding day, but all the others which have taken place since that time. At the time of the earthquake, during the night, flames were seen to issue from the ground in the neighbourhood of Reggio towards the sea, where the explosion extended, so that many countrymen

ran away for fear; these flames issued exactly from a place where some days before an extraordinary heat had been perceived. After the great concussion there appeared in the air, towards the east, a whitish flame, in a slanting direction; it had the appearance of electric fire, and was seen for the space of two hours.

In consequence of the terrible shock, many countries and cities, especially those situated in the neighbourhood and neck of our peninsula as you go from Tiriolo to the river Ringitola, and which had suffered nothing before, were overturned. Curinga, Maida, Cortale, Girifalco, Borgia, St. Flora, Settingiano, Marcellinari, Tiriolo, and other countries of less importance were almost entirely destroyed, but with the loss of very few people. Many hundreds, however, perished in Maida, Cortale, and Borgia. Many hills were divided or laid level; many apertures were made in the surface of the earth throughout the whole surface which lies between the two vallies occupied by the rivers Corace and Lameto, towards Angitola. Out of many of these apertures a great quantity of water, coming either from the subterraneous concentrations, or the rivers themselves in the neighbourhood of which the ground broke up, spouted during several hours. From one of these openings in the territory of Borgia, about a mile from the sea, there came out a large quantity of salt water, which imitated the motions of the sea itself for several days. Warm water likewise issued from the apertures made in the plains of Maida. In all the sandy parts, where the explosion took place, there were observed, from distance to distance, apertures in the form of an inverted cone, out of which likewise came water. This seems to prove that from thence escaped a flake of electric fire. Fissures of this kind are particularly met with along the banks of the Lameto.

Amidst the various phænomena, which either preceded or followed the earthquake, the two following are remarkable. On the very day of the earthquake the water of a well in Maida, which heretofore people used to drink, was infected with so disgustful a sulphureous taste, that it was impossible even to smell to it. On the other hand, at Catanzaro, the water of a well, which before could not be used, because of a smell of calcination that it had, became so pure as to be drunk extremely well. In Maida itself many fountains were dried up by the earthquake of the 28th. This likewise happened at other places; but many also broke in several spots where there had

been none before, as did also several mineral springs, of which before there was not a vestige. Commonly, however, the fountains became more swelled and more copious, and emitted a larger volume of water than usual. The waters of some fountains were also observed to be troubled, and to assume a whitish or yellowish colour, according to the countries through which they passed. For a long time before the earth shook, the sea appeared considerably agitated, so as to frighten the fishermen from venturing upon it, without any visible winds to make it so. Our volcanoes too, as I am confidently assured, emitted no eruptions for a considerable time before; but there was an eruption of Etna in the first earthquake, and Stromboli showed some fire in the last.

[*Phil. Trans.* 1783.]

CHAP. XXV.

CAVERNS, GROTTOS, AND OTHER NATURAL EXCAVATIONS.

No man who has attentively perused the preceding chapters—who has carefully contemplated the mode in which the solid crust of the earth appears to have been formed and aggregated on its emerging from a state of chaos, and broken, undermined, decomposed, and recombined into new shapes by the posterior agency of subterranean gasses, volcanoes, and earthquakes, of confined air, vapours, and water, can be much surprised at finding that its structure is in many instances to be met with rent asunder into chasms of awful and tremendous depth, or scooped out into hollows of the most grotesque and romantic appearance.

From an almost incalculable variety of phænomena of this description, our limits will only allow us to select a few of those that are of the most singular character; and in doing this we shall strictly confine ourselves in the present place to those that are of *natural* origin alone: reserving our account of those that have been produced solely or chiefly by *human labour* for that division of our work which will take a general survey of the wonders and curiosities of ART.

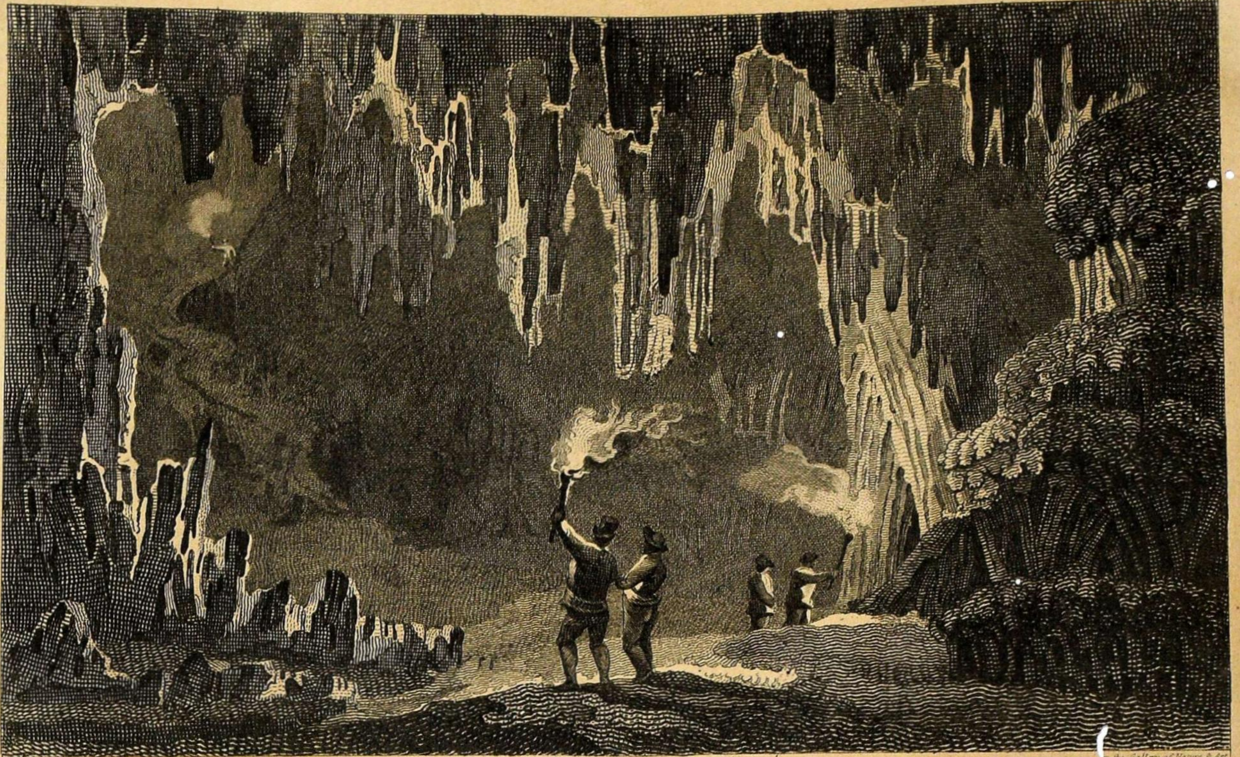
SECTION I.

Brief Survey of Foreign Caverns.

THERE are few countries that have not to boast of a variety of natural excavations, which from their extent or structure have in all ages become objects of popular attention, and have not unfrequently been interwoven into the traditions or superstitions of a remote and doubtful antiquity. Near the city of Heraclea, whose walls rose on the shores of the Euxine, was situated a cave of this description, which was visible in Xenophon's time, and of two furlongs depth. It was through this that Hercules, to whom the city of Heraclea was dedicated, was feigned to have descended into the infernal regions, and to have dragged to light the three-headed Cerberus. The vestiges of the city still remain, and are shewn by the Turks under the name of Eregri: the cavern, however, has long been destroyed, or at least closed up to a considerable extent at the mouth. The Averno, in the Phlegrean fields, offers an excavation of a similar kind, and is equally celebrated in traditionary story for its being an entrance to the infernal regions; but as this cavity is still more famous for its sheet of water and the deadly vapours that are said to issue from it, we shall describe it more particularly under the chapter upon Lakes.

The volcanic country about Rome is peculiarly diversified by natural cavities of great extent and coolness, on which last account we are told by Seneca, that the Romans were accustomed to erect their country seats in their vicinity, to enjoy their refreshing chillness in the summer season. He gives a particular account of two such grottos belonging to the villa of Vatia; and it was in a place of this kind that Tiberius was nearly destroyed whilst at supper; for during this banquet its roof suddenly gave way and buried several of his attendants in its ruins; which so fearfully alarmed the rest, that every one fled away and abandoned the emperor except Sejanus, who stooping upon his hands and knees, and covering the body of Tiberius with his own, received all the stones that fell from the roof, so that, though he himself sustained considerable injury, the emperor escaped unhurt *.

* Tacit. Ann. lib. iv. cap. 60.



Engraved by Ranson, from a Drawing by L. Clennell, | *For the Gallery of Nature & Art.*

GROTTO OF ANTIPAROS,

IN THE LEVANT.

London: Published by R. Wilks, 89 Chancery Lane, April 15, 1813.

We meet with a singular grotto or cavern in the rocky island of Antiparos, the ancient Oliaros in the Levant, which lies about two miles to the west of the celebrated Paros, and is not more than sixteen miles in circumference, but has a port accessible to small barks. This extraordinary grotto appears to be about forty fathoms high, and fifty broad: the roof forms a pretty good arch, and every where entertains the eye with an infinite variety of figures of a white transparent crystalline marble, representing vegetables, marble pillars, and a superb marble pyramid, as regular as if formed by art.

Every one has heard of the labyrinth of Crete or Candia. This, which is a natural curiosity, runs under a small hill at the foot of Mount Ida, in a thousand intricate and irregular meanders, something like that of Egypt, which, as being a product of art, belongs to another division of the present work. The entrance is an aperture seven or eight paces broad, but in some places so low that it cannot be entered without stooping. The ground is rugged and uneven, but the top is level, and consists of an horizontal layer of stones. The principal passage, in which there is less danger of a person's being bewildered than in the others, is about twelve hundred paces in length, and reaches to the end of the maze, where are two spacious chambers. The most dangerous part of the mainwalk is about thirty paces distance from its mouth; for if a person happens there to take a wrong course, he is soon bewildered amidst the innumerable windings which occur, and his extricating himself is very difficult, and even uncertain; but travellers always provide themselves with guides and torches. There is little appearance of this place having ever been a stone quarry. Tournefort considers it as effected by human labour, which, in that case, must have been very great; but it is most probable that human exertions have greatly extended what nature had formed. Some persons assert this cavern to be the ancient labyrinth of Dædalus; but Pliny distinctly informs us, that even in his time not a vestige of this celebrated maze was to be seen.

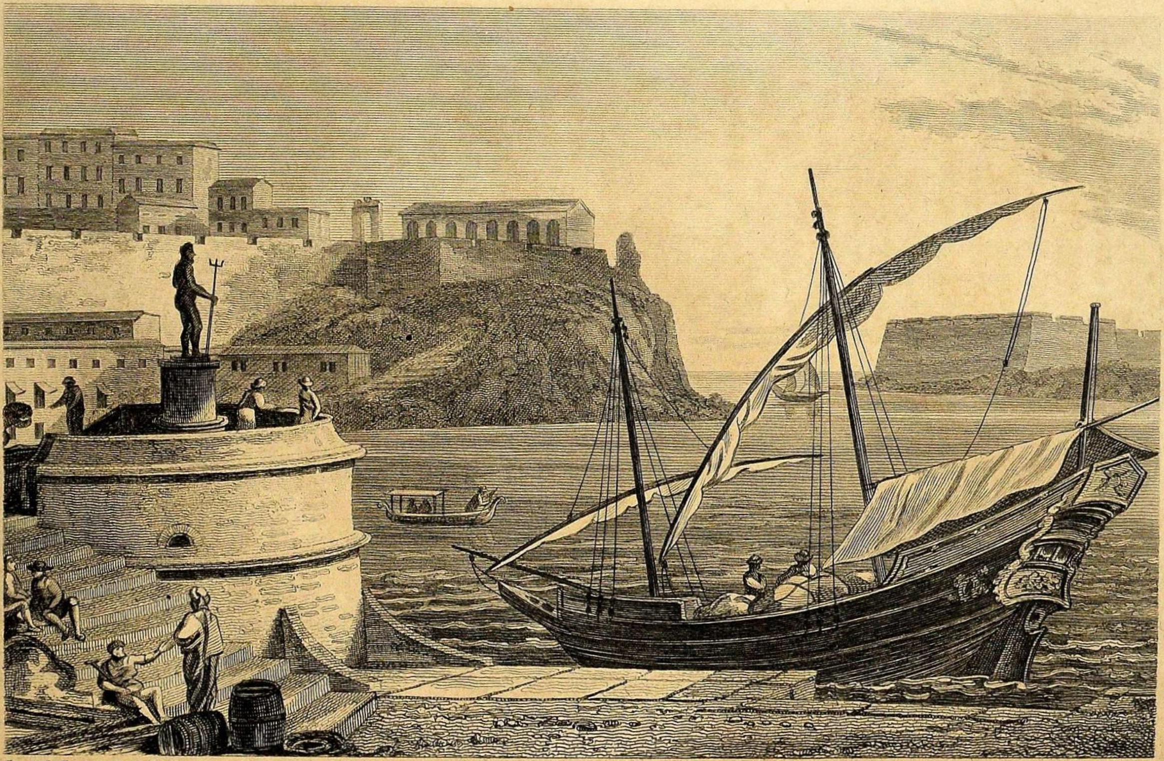
Milo, anciently called Melos, latitude 36° 41′ north, longitude 25° east from Greenwich, lies near sixty miles north of Candia, and is fifty miles in circumference. It consists almost entirely of one hollow, porous r[illegible] which is macerated, as it were, by the sea-water; and the[illegible] continual subterraneous fire is felt, on introducing the [illegible] holes of the rock: a place in the island

is always burning, and the earth around it smokes like a chimney. Great quantities of alum and sulphur are found; for here alum grows in some natural caverns in the form of flat stones between nine and ten inches thick. The ancients highly esteemed the alum of this island; and Pliny, in his Natural History *, gives a clear description of this concrete substance. The island also produces plume alum, which grows on the rock. Sulphur is found in one particular place perfectly pure, and, as it were, sublimated; this is in a cavern the bottom of which is full of sulphur continually burning. In this cavern, which lies on the very edge of the sea, is a hot sulphureous spring, salutary in various disorders, particularly eruptive ones, on which account it is very much resorted to by the Greek inhabitants of the neighbouring islands. A town of the same name is situated on the eastern part of the island, and has one of the largest and best harbours in the Mediterranean, which is very convenient for vessels navigating along the Levant. The inhabitants, about five thousand in number, are Greeks, and are said to be given up to voluptuousness, and entirely insensible to the danger of their situation.

On the island of Malta, adjoining to the church which is dedicated to St. Paul, near Citta Vecchia, is the celebrated grotto in which this apostle is said to have been imprisoned, and which is hence regarded with the utmost veneration. This grotto is exceedingly damp, and produces, probably by a petrifying quality in the water, a whitish kind of stone, which the natives say, when reduced to powder, is a sovereign remedy in many diseases, and saves the lives of many thousands every year. There is not a house in the island that is not provided with a quantity of it; and many boxes of it are said to be annually sent to Sicily and Italy, to the Levant, and even the East Indies. "Its taste," says Brydone, "is like that of exceeding bad magnesia;" and he believes it has much the same effects. It promotes profuse perspiration, is given in the small-pox and fevers, and is esteemed a certain remedy against the bite of all venomous animals. There is a very fine statue of St. Paul in the middle of this grotto, to which miraculous properties are ascribed.

In the province of Upper Foix, in France, now the department of Arriege, are several natural caverns, in which are very singular figures, formed by the petrifying quality of the waters

* Nat. His. lib. xxxv.



Engraved by Hay, from a Drawing by Craig

For the Gallery of Nature & Art

THE VALETTA & PORT OF MALTA.

London: Published by R. Wilks, 89, Chancery Lane. Feb. 1. 1814.

In the neighbourhood of the village of Szelitze in Upper Hungary, we have various descriptions of a very singular and extraordinary excavation. The neighbouring country is hilly, and abounds with woods, and the air is sharp and cold. The entrance of the above cavern, which fronts the south, is eighteen fathoms high, and eight broad, and consequently wide enough to receive the south wind, which here generally blows with great violence; but the subterranean passages, which consist entirely of solid rock, winding round, stretch away farther to the south than has been yet discovered. As far as people have gone, the height is found to be fifty fathoms, and the breadth twenty-six; but the most inexplicable singularity is, that in the midst of winter the air in this cavern is warm; and when the heat of the sun without is scarcely supportable, the cold within is not only very piercing, but so intense, that the roof is covered with icicles of the size of a large cask, which spreading into ramifications, form very grotesque figures. When the snow melts in spring, the inside of the cave, where its surface is exposed to the south sun, emits a pellucid water, which immediately congeals as it drops, and thus forms the above icicles; and the very water that drops from them on the sandy ground, freezes in an instant. It is even observed, that the greater the heat is without, the more intense is the cold within; so that in the dog-days, all parts of this cavern are covered with ice, which the inhabitants use for cooling their liquors. In autumn, when the nights grow cold, and the heat of the day begins to abate, the ice in the cave begins to dissolve, so that by winter no more ice is seen: the cavern then becomes perfectly dry, and has a mild warmth. At the same time it is surprising to see the swarms of flies, gnats, bats, owls, and even of foxes and hares that resort hither, as to their winter retreat, and remain here till the return of spring. Above the cavern the hill rises to a very great height.

About two German miles from Adlersberg, in Carniola, is a remarkable cavern, named St. Magdalen's Cave. The way to it being covered with stones and bushes, is extremely troublesome; but the great fatigue in going is overbalanced by the satisfaction of seeing such an extraordinary cavern. You first descend into a hole, where the earth seems to have fallen in for ten paces before you reach the entrance, which resembles a fissure in a huge rock caused by an earthquake. Here torches are always lighted to conduct travellers, for

the cave is extremely dark. This wonderful excavation seems as if divided into several large halls, and other apartments. The vast number of pillars by which it is ornamented by nature, give it a superb appearance, and are extremely beautiful; for they are as white as snow, and have a kind of transparent lustre, not unlike that of white sugar-candy. The bottom is of the same materials; so that a person may imagine he is walking among the ruins of some stately palace, amidst noble pillars and columns, partly mutilated and partly entire. From the top, sparry icicles are seen every where suspended, in some places resembling wax tapers, which, from their radiant whiteness, appear extremely beautiful. All the inconvenience here arises from the inequality of the bottom, which may make the spectator stumble while he he is contemplating the beauties above and around him.

Among the Alps we occasionally meet with tremendous chasms, several hundred yards wide at the mouth, and of a frightful depth, and in some instances unfathomable. Sometimes the road winds at the edge of such a precipice, whilst other roads are formed at the bottom of two severed rocks; and the traveller, in either situation, has his apprehensions of danger strongly awakened; and during his passage in the deep sunk roads, shudders at beholding the fearful precipices that hang over him, the sides of which correspond so exactly with each other, as plainly to indicate having been, at some period of time, torn asunder by some violent agitation of nature.

About twelve miles to the southward of Santa Cruz, in the Canary Islands, close to the sea, is a cave, with a church or chapel, called Our Lady of Candelaria, in which is a little image of the Virgin Mary, about three feet high, holding a green candle in one hand, and in the other an infant Jesus, who has a gilt bird in each hand. This chapel received its name of Candelaria from its being pretended that on the eve of the purification of the Holy Virgin, a great number of lights are constantly seen going in procession round the cave in which the image is placed; and the credulous assert, that in the morning drops of wax are found scattered about the sea-shore. This image of the Virgin is held in the highest veneration, on account of the many miracles it is said to have performed; and her chapel is adorned with so many ornaments, that it is the richest place in all the seven islands. At a certain season of the year, most of the in-

habitants of the island go thither in pilgrimage, when troops of young girls march, singing in an agreeable manner the praises of the Virgin, and the miraculous deeds of the image.

In the Andes of South America, where every thing is exhibited on the largest scale, there are some such clifts not less than a mile in width, and of an immeasurable depth, whilst others of a more limited depth, at their bottom stretch in an horizontal direction, forming caverns of an immense capacity.

The island of Barbadoes abounds with caves, the most remarkable of which, called Cole's Cave, is situated almost in the bottom of a melancholy hideous gully, or deep chasm made between hills by repeated torrents of rain. This gully is about a hundred and sixty-five feet deep, from which nothing is to be seen above but the tops of high rocks and impending cliffs, through the branches of lofty trees. The descent toward the entrance of this cave is by a steep craggy precipice of great height, where the security from falling depends much upon the good hold which is taken of the roots of trees and branches of underwood. Having rather slid than walked down in this manner a considerable way, you are suddenly within an inclosure of very high perpendicular rocks, where the light of the sky is admitted by two holes in the roof. On the west side of this gloomy apartment lies the mouth of the cave, which is of considerable size. Upon the first entrance into it, the light of the day begins to grow weak, and proves but an uncertain guide. Twenty yards farther, it appears no stronger nor brighter than the glimmering of a star in a dull hazy night, and a few steps more envelopes you in total darkness. It extends about a quarter of a mile from its entrance, is in no part very lofty, but is divided into different apartments: through it runs a spring of clear water.

We have already observed, that in hot climates these natural excavations have always been highly prized by the wealthy and voluptuous as the most refreshing summer retreats. In many of them, indeed, the cold continues with little or no variation through the whole year, and is too intense to be borne in the hottest season.

In France and Italy *, these kinds of natural icehouses are frequent, and supply this pleasant luxury at a very cheap rate. Thus

* See also, for other natural caverns, the rock of Gibraltar, chapter xxx. sect. vii. of the present book.

towards the east of Vesoul, in the former province of Franche Comté, is a cavern, which will produce in one hot day more ice than can be carried away in eight days. It measures thirty-five feet in length, by sixty in width; and the large pendent masses of ice which hang from the roof produce a very pleasing effect. When mists are seen in this cavern, they are regarded by the neighbouring peasantry as infallible prognostics of approaching rain; and it is worthy of observation, that although the waters in the interior are always frozen in summer, they become liquid in winter.

A grotto near Douse, in the same province, forms a similar ice-house, and is remarkable on account of the various forms of its congelations, which represent a series of columns, sustaining a curious vault, which appears to be carved with figures of men, animals, trees, &c.

In a little wood, about five leagues from Besançon, there is an opening, formed by two masses of rock, and leading, by a long and narrow declivity, to the entrance of a cavern, which is a hundred and forty-six toises below the level of the country.

This cavern, which is sixty feet wide, and eighty feet high at the entrance, exhibits an oval cavity of one hundred and thirty-five feet in breadth, and one hundred and sixty-eight in length. To the right of the entrance is a deep and narrow opening, bordered with festoons of ice, which distilling in successive drops on the bottom of the grotto, form a mass about thirty feet in diameter. A similar one but rather smaller is seen on the left which is produced by the water that drips in less abundance from the imperceptible fissures in the roof. The ground of the grotto is perfectly smooth, and covered with ice eighteen inches thick; but the top, on the outside, is a dry and stony soil, covered with trees, and on a level with the rest of the wood. M. Croismarc, to whom we are indebted for these particulars, asserts, that the cold in the grotto is very great, and that although the external atmosphere was sufficiently warm when he made his observations, he was several times compelled to abandon the interior from its extreme chilliness.

Engrav'd from a Drawing by Clennell. *for the Gallery of Nature & Art.*

INTERIOR VIEW OF THE PEAK OF DERBYSHIRE.

London Published by R. Wilks 89 Chancery Lane July 15 1813.

SECTION II.

Peak of Derbyshire.

THIS peak has been long famous for the seven following places, or wonders, as they were formerly called: Mam-tor; Pool's Hole; Devil's Hole; Elden Hole; the Alternating, or Ebbing and flowing, Well; Buxton Well; and the Duke of Devonshire's magnificent seat called Chutworth. Of these, the first four only belong to the present department in the GALLERY OF NATURE; the two next will have niches assigned to them a few chapters hence; and the last appertains to our Second Part, constituting the GALLERY OF ART.

MAM-TOR, or the Mother Bank, is a huge precipice facing the east, or south-east, which is said to be perpetually splintering and throwing down great stones, on a smaller mountain below it; while yet neither the one augments nor the other decreases in size. This mountain is chiefly composed of a peculiar kind of schist or slate, called provincially black shale, and great-stone: and such is the nature of this slate, that though very hard before it is exposed to the air, it very easily crumbles to dust upon such exposure; and hence the shale is perpetually wasting by the action of the rain and snow; while the larger and harder masses of stone, being hence loosened and disengaged, necessarily fall from their positions; in many places, before their descending, producing a cavernous appearance, and even a romantic, overhanging scenery, highly dangerous to be approached. That it is only at the times of snow and rain-storms that the mountain wastes, is affirmed by the most intelligent of the neighbouring inhabitants: and that the decay is not continual, Mr. Martyn, who has published an account of Mam-tor in the Philosophical Transactions for 1729, affirms of his own knowledge; having not only taken a close survey of it, but also climbed up its steepest precipice, without tracing any other shivering in the mountain than what the treading of his own feet in the loose crumbled earth occasioned.

POOL'S HOLE is a singular horizontal opening at the foot of a mountain near Buxton, and is said to have derived its name from a notorious robber who secreted himself for a long time from the pursuit of justice in the stupendous cavern to which it leads

The entrance is extremely low and narrow; but it gradually opens into a spacious and lofty concavity, like the interior of a Gothic cathedral. In a cavern to the right, called Pool's Chamber, is a curious echo; and the sound of a rapid stream which runs through the great vault produces a fine effect. The innumerable drops of water which depend from the roof and sides are also worthy of admiration; for they not only reflect innumerable rays from the lights carried by the guides, but, being of a petrifying quality, they form many fanciful resemblances of men, lions, dogs, and other animals, and of organs, lanterns, and flitches of bacon. The Queen of Scots' pillar, said to have taken its name from a visit of the unfortunate Mary, during her abode at Chatsworth, is clear and bright like alabaster, but probably partakes more of the nature of spar, with which the circumjacent country abounds. This pillar is the boundary of most people's curiosity; but there is a steep ascent for nearly a quarter of a mile beyond it, which terminates in a hollow in the roof, called the Needle's Eye, where a candle, if judiciously placed, appears like a star peeping from a cloudy sky.

The entrance to another cavern called the DEVIL'S HOLE, is extremely magnificent: being situated in a gloomy recess, between two ranges of perpendicular rocks; and having on the left a rivulet which issues from the cave, and pursues its foaming course over craggy and broken masses of limestone. A vast canopy of rock forms the mouth of this stupendous excavation, and assumes the appearance of a depressed arch, which extends one hundred and twenty feet in width, forty-two in height, and about ninety in receding depth.

At the first entrance, a spectator is surprized to find that a number of twine-makers have established their residence and manufactory within this tremendous gulf; and the combinations of their rude appearance and machines with the sublime features of the natural scenery, impresses the mind with an indescribable emotion of awe. After proceeding about ninety feet, the roof becomes lower, and a gentle descent conducts, by a detached rock, to the interior entrance, where the blaze of the day wholly disappears, and all further researches must be pursued by torch-light.

The passage now becomes extremely confined, and the visitor is obliged to proceed about twenty yards in a stooping posture: but on his arrival at a spacious opening, called the Bell-house, he is

again enabled to stand upright, and proceeds, without inconvenience, to the brink of a lake, where a small boat is ready to convey him to the interior of the cavern, beneath a massive rock, which stoops within twenty inches of the surface of the water.

Beyond this lake is a spacious vacuity, about two hundred and twenty feet long, two hundred broad, and, in some parts, a hundred and twenty feet high; but, from the want of light, neither the roof nor distant sides of this vast abyss can be plainly discerned.

Near the termination of a shallow stream, called the Second Water, is a projecting pile of rocks called Roger Rain's House, from the circumstance of water incessantly dripping from the crevices of the roof. Beyond this, opens another tremendous hollow, called The Chancel, where the rocks appear much broken, and the sides are literally covered with stalactical incrustations. Here the stranger is generally surprised by an invisible vocal concert, which bursts in discordant tones from the upper regions of the chasm: "Yet," says a respectable tourist*, "being unexpected, and issuing from a quarter where no object can be seen, in a place where all is still as death, and calculated to impress the imagination with solemn ideas, it can seldom be heard without that mingled emotion of awe and pleasure, astonishment and delight, which is one of the most interesting feelings of the mind." At the conclusion of the strain, the choristers (consisting of eight or ten women and children) are seen ranged in a hollow of the rock, about fifty feet above the floor.

After passing The Devil's Cellar, and the Halfway-house (neither of which are particularly worthy of observation) the visitor proceeds beneath three natural arches to a vast concavity, which, from its resemblance to a bell, is called Great Tom of Lincoln. From this point the vault gradually descends, the passage contracts, and at length leaves no more room than is sufficient for the passage of the stream, which continues to flow through a subterraneous channel.

The entire length of this wonderful cavern is two thousand two hundred and fifty feet, and its depth, from the surface of the mountain, about six hundred and twenty. A curious effect is produced by the explosion of a small quantity of gunpowder, wedged into the rock in the interior of this cave; for the sound appears to roll along the roofs and sides, like a tremendous and continued peal of thun-

* Mr. Warner.

der. The effect of the light, on returning from these dark recesses, is particularly impressive; and the gradual illumination of the rocks, which become brighter as they approach the entrance, is said to exhibit one of the most interesting scenes that ever employed the pencil of an artist, or fixed the admiration of a spectator.

ELDEN HOLE is a stupendous chasm in the vicinity of the preceding, formerly represented as altogether unfathomable, and teeming, at a certain depth, with such noxious air, that no animal could respire it without inevitable destruction. Cotton affirmed more than a century ago, that he let down eight hundred and eighty-four yards of line, of which the last eighty yards were wet, without finding a bottom; and it has been confidently asserted, that a poor man, who was once lowered in a basket to the depth of two hundred yards, on being drawn up died in a state of delirium. We cannot, however, give a better description of the actual depth and dimensions of this singular cavern, than the following of Mr. Lloyd's, as contained in volume xiii. of the Philosophical Transactions Abridged.

Mr. Lloyd having seen several accounts of the unfathomable depth of Elden Hole, in Derbyshire, and being in that neighbourhood, he was inclined to make some inquiries about that noted place, of the adjoining inhabitants; who informed him that about fourteen or fifteen years before, the owner of the pasture in which this chasm is situated, having lost several cattle, had agreed with two men to fill it up; but finding no visible effects of their labour, after having spent some days in throwing down many loads of stones, they ventured to be let down into it, to see if their undertaking was practicable; when, on finding at the bottom a vast large cavern, they desisted from their work, as it would have been almost impossible to have procured a sufficient quantity of stones to have filled it up. On inquiry of one of these men whether there were any damps at the bottom; and being assured in the negative, Mr. L. procured two ropes of 40 fathoms nearly in length, and eight men to let him down.

For the first twenty yards Mr. L. was let down, he could assist himself with his hands and feet, as it was a kind of confined slope; but after that the rock jetted out into large irregular pieces, on all the three sides next him; and on that account he met with some difficulty in passing, for about the space of ten yards more; at which depth the rope was moved at least five or six yards from the perpen-

dicular. Thence down, the breadth was about three yards, and the length at least five or six, through craggy irregular slits of rock, which was rather dirty, and covered with a kind of moss, and pretty wet, till he came within about twelve or fourteen yards of the bottom, and then the rock opened on the east side, and he swung till he descended to the floor of the cave, where he perceived there was light enough came from the mouth of the pit, though at the distance of sixty-two perpendicular yards, to read any print. When at the bottom, he perceived that the cavern consisted of two parts; the first being a cave, in shape not much unlike that of an oven; and the latter, a vast dome of the form of the inside of a glass-house; with a small arched passage from the one to the other, through which a slope of loose stones, that have been thrown in from time to time, extends from the wall at the west side of the first dome, to almost the bottom of the second cave or dome, with such an angle, that the farther end of the cave is lower by twenty-five yards than the place where he first landed.

The diameter of this cavern may be nearly fifty yards: the top he could not trace with the eye; but he had reason to believe it extended to a vast height; for when nearly at the top of one of the incrusted rocks, at the height of about twenty yards, he could find no closure of the dome, though he then saw much farther than when he stood at the bottom.

As to the particular curiosities to be met with in the small cavern, they are not worth mentioning; indeed he did not meet there with any stalactitical incrustations whatever; but the wall consisted of rude and irregular fragments of rock. Among the singularities in the second cavern, he particularly observed the following; climbing up a few loose stones on the south side, he descended again through a small slit into a little cave, four yards long and irregular, as to height not exceeding two yards; and the whole lined with a kind of sparkling stalactites, of a fine deep yellow colour, with some small stalactitical drops hanging from the roof. Facing the first entrance is a most noble column, of the same kind of incrustation, above thirty yards high; and proceeding on to the north, he came to a large stone, covered with the like matter; and under it was a hole two yards deep, lined with the same; whence sprung a rock consisting of vast solid round masses, like the former in colour, though not in figure, on which he easily ascended to the

height of twenty yards, and got some fine pieces of stalactites, pendent from the cragged sides which joined this rock.

After this, proceeding forward, he came to another pile of incrustations, different from the two former, and much rougher; and which was not tinged with such a yellow, but rather with a brown colour; and at the top of this also is a small cavern, into which he went. The last thing he took notice of, was the vast drops of stalactites, hanging like icicles from every part of the vault; some of which were as large as a man's body, and at least four or five feet long. The greatest part of the walls of the large cavern was lined with incrustations, and they were of three kinds: the first, being the deep yellow stalactites; the second, being a thin coating, like a kind of light stone-coloured varnish on the surface of the limestone, and which glittered exceedingly by the light of the candles; and the third being a sort of rough efflorescence, every minute shoot resembling a kind of rose-flower.

Having satisfied his curiosity with a view of this astonishing vault, he began to return. Fastening the rope to his body, he gave the signal to be drawn up; which he found to be a much more difficult and dangerous task than the descent, owing to his weight drawing the rope into clefts, between the fragments of the rock, which made it stick; and to his body jarring against the sides, which he could not possibly prevent with his hands. Another circumstance also increased the danger, which was, the rope loosening the stones over head, whose fall he every instant dreaded.

After writing the above, Mr. L. was informed, there was formerly the mouth of a second shaft in the floor of the great cavern, somewhere under the great heap of stones; and that it was covered up by the miners, at the time when so many loads were thrown in from the top. It is reported to have gone down a vast depth farther, and to have had water at the bottom; but he did not perceive any remaining appearance of such opening himself, nor did the miners, who went down with him, say any thing about it.

The above description was communicated to the Royal Society in 1771, by Edward King, Esq. who makes the following judicious observations upon it. "If it be further considered, that in sounding such great depths, the weight of the rope may often be mistaken for the weight of the plummet; and that hence the rope may continue de-

scending, and coiling up, first at the bottom, and afterwards at other places where it is accidentally stopped, till it be at length hindered in its descent by some projections of the rock nearer the mouth of the shaft; this will account for Mr. Cotton's letting down eight hundred and eighty-four yards, while the water at the bottom of the second shaft will account for eighty yards being wet; as so many might coil up in the water, let it have been ever so shallow, and as the rest, beyond the real depth of the chasm, might coil up either in the great or little cave. Again, the many craggs on each side the first shaft, and probably also on each side the second, must retard any stone in its fall; and by that means will account for the length of time a body takes in descending; which must be a great deal longer than if it fell in open space: and hence Dr. Short (who has given a calculation, formed from the time of the descent of heavy bodies, according to the Newtonian principles of gravitation) was misled to conclude, though very ingeniously, that this chasm was four hundred and twenty-two yards deep. And, lastly; the falling of stones into the water, at the bottom of the second shaft, and the increase of the sound thus made, partly from the reverberation at the sides of the great cavern, and partly from the form of the upper shaft, which is not very unlike that of a speaking trumpet, might occasion that astonishing noise, which is said to have been heard at various times formerly, on throwing stones into this gulf; but which has not been heard of late years, in a manner at all agreeable to old reports."

And as both Mr. Lloyd, and also a miner's wife, from whom King had his information, mentioned there being water at the bottom of the second shaft, it appears highly probable, that this water is the continuation of a subterraneous river; and indeed of that very river which runs out of the mouth of the great cavern at Castleton: for it is observed by the country people in the neighbourhood, that there is a large quantity of grit-stone forming in the earth near Elden Hole, but none near Castleton; and yet, on high floods, the river at Castleton washes great quantities of fragments of that very grit-stone out of the mouth of Castleton cavern.

There is also a tradition, which, however ridiculous, ought to b[illegible] preserved. Many years ago, and old woman, hunting her goo[illegible] fell down into Elden Hole; but some days after, she heard it w[illegible] seen at the mouth of Castleton cavern, and actually received it safe again from thence; the goose having by the fluttering of its wings,

preserved itself from being dashed to pieces in its fall; and having found its passage safely through the subterraneous river.

[*Phil. Trans. Abr. Vol.* II, 1681.]

SECTION III.

Mendip Caverns and Grottos. By Mr. John Beaumont.

ON the south side of Mendip-hills, within a mile of Wells, is a famous grotto, known by the name of Okey-hole, much resorted to by travellers. The entrance of it is in the declivity of those hills, which is there environed with rocks, having near it a precipitous descent about ten or twelve fathoms deep, at the bottom of which there always issues from the rock a considerable current of water. The naked rocks above the entrance shew themselves for about thirty fathoms in height, though the whole ascent of the hill above it is about a mile, and is very steep.

At first entering this vault, you go upon a level; but advancing farther into it, you find the way rocky and uneven, sometimes ascending and sometimes descending. The roof in the highest part is about eight fathoms from the floor, and in some places it is so low that a man must stoop to pass through. Its width is also various, in some parts it is about five or six fathoms, in others not above one or two; it extends itself in length about two hundred yards.

At the farther part of this cavern there rises a good stream of water, large enough to drive a mill, which passes all along one side of the cavern, and at length slides down about six or eight fathoms between the rocks, and then pressing through the clefts of them, discharges itself into a valley. This river within the cavern is well stored with eels, and has some trouts in it, which must of necessity have been engendered there, and not come from without, there being so great a fall near the entrance. In a dry summer I have seen a number of frogs all along the cavern, to the farthest part of it, and other little animals in some small cisterns of water there. Before arriving at the middle of this vault, you find a bed of very ine sand, which is much used by artists to cast metals in. On the f at certain places, hang multitudes of bats, as usual in all caerns whose entrance is upon a level, or somewhat ascending or descending.

The next cavern of note lies about five miles from this, on the southwest part of Mendip-hills, near a place called Cheddar, famous

for cheese; from this place you may pass up a narrow valley about a mile in length, being bounded with precipitous rocks on the east and west, some of a very considerable height. To enter into this cavern, before you reach half way this valley, you must ascend about fifteen fathoms on those rocks which bound it to the east. This cavern is not of so large extent as the former, neither has it any thing peculiar in it. These two caverns have no communication with the mines.

It is generally observed, that wherever mines of lead-ore are, there caverns of various kinds and situations are found. The most considerable in Mendip-hills is a cavern in a hill called Lamb. First a perpendicular shaft descends about ten fathoms, then yon come into a leading vault, which extends itself in length about forty fathoms; it runs not on a level, but descending, so that when you come to the end of it you are twenty-three fathoms deep by a perpendicular line; the floor of it is full of loose rocks: its roof is firmly vaulted with lime-stone rocks, having flowers of all colours hanging from them, which present a most beautiful object to the eye, being always kept moist by the distilling waters. In some parts the roof is about five fathoms in height, in others so low that a man has much ado to pass by creeping; the width is mostly about three fathoms. This cavern crosses many veins of ore. About its middle, on the east side, lies a narrow passage into another cavern, which runs between forty and fifty fathoms in length. At the end of the first cavern there opens another large one.

I have been in many other caverns upon Mendip-hills. The frequency of caverns on those hills may be easily guessed at, by the frequency of swallow-pits, which occur there in all parts, and are made by the falling in of the roofs of caverns; some of these pits being of a large extent, and very deep; and sometimes our miners, sinking in the bottom of these swallows, have found oaks fifteen fathoms deep in the earth.

[*Phil. Trans. Abr. Vol.* II. 1681.]

SECTION IV.

Pen-park Hole, in Gloucestershire. By Sir Robert Southwell.

THERE is a place in Gloucestershire called Pen-park, about three miles from Bristol, and above three from the Severn, where some

miners for lead discovering a large hole in the earth, one Captain Sturmy, a warm inquisitive seaman, who has written a large folio on navigation, would needs descend into it, and his narrative was as follows:

"On the 2d of July, 1669, I descended by ropes affixed at the top of an old lead-ore pit, four fathoms almost perpendicular, and from thence three fathoms more obliquely, between two great rocks, where I found the mouth of this spacious place, from which a miner and myself lowered ourselves by ropes, twenty-five fathoms perpendicular, into a very large place, which resembled to us the form of a horse-shoe; for we stuck lighted candles all the way we went, to discover what we could find remarkable. At length we came to a river or great water, which I found to be twenty fathoms broad, and eight deep. The miner would have persuaded me that this river ebbed and flowed, for that some ten fathoms above the place where we now were, we found the water had sometime been; but I proved the contrary, by staying there from three hours flood to two hours ebb, in which time we found no alteration of this river. Besides its waters were fresh, sweet, and cool, and the surface of this water as it is now at eight fathoms deep, lies lower than the bottom of any part of the Severn sea near us, so that it can have no communication with it, and consequently neither flux nor reflux, but in winter and summer, as all stagnant lakes and loughs (which I take this to be) have. As we were walking by this river, thirty-two fathoms under ground, we discovered a great hollowness in a rock, some thirty feet above us, so that I got a ladder down to us, and the miner went up the ladder to that place, and walked into it about seventy paces, till he had just lost sight of me, and from thence cheerfully called to me, and told me he had found what he looked for, a rich mine; but his joy was presently changed into amazement, and he returned affrighted by the sight of an evil spirit, which we cannot persuade him but he saw, and for that reason he will go thither no more.

"Here are abundance of strange places, the flooring being a kind of a white stone, enamelled with lead-ore, and the pendant rocks were glazed with salt-petre, which distilled upon them from above, and time had petrified.

"After some hours stay there we ascended without much hurt,

except scratching ourselves by climbing the sharp rocks. But for four days after my return I was troubled with a violent head-ach, which I impute to my being in that vault."

Captain Sturmy falling from his head-ach into a fever, and dying; what from his death, and the opinion of an evil-spirit, nobody was willing to have any more to do with the said hole from that time to this.

But Captain Collins, commander of the Merlin yacht, who is by his Majesty appointed to take s survey of the coast of England, coming to the Severn for that purpose, and visiting Sir Robert Southwell, near Kingroad, Sir Robert told him how the story of this hole had amused the country; and that the narrative had formerly been sent to his Majesty and the Royal Society; and that there wanted only some courage to find out the bottom of it. The captain resolved to adventure, and on the 18th and 19th of September, 1682, he took several of his men, with ropes and tackling fitting to descend, with lines to measure any length or depth, also with candles, torches, and a speaking-trumpet. What he found does much lessen the credit and terror of this hole, as will appear by the figure he took thereof, and the description following:

"It is down the tunnel from the superficies to the opening of the cavity below thirty-nine yards. Then the hole spreading into an irregular oblong figure, is in the greatest length seventy-five yards, and in the greatest breadth forty-one yards; from the highest part of the roof to the water was then nineteen yards; the water was now in a pool, at the north end, being the deepest part, it was in length twenty-seven yards, in breadth twelve, and only five yards and a half deep; two rocks appeared above the water all covered with mud, but the water sweet and good; there was a large circle of mud round the pool, and far up towards the south end, which showed that the water has at other times been six yards higher than at present.

"The tunnel or passage down was somewhat oblique, very ragged and rocky; in some places it was two yards wide, and in some three or four, but nothing observable therein, save here or there some of that spar which usually attends the mines of lead-ore. In the way, thirty yards down, there runs in, southward, a passage of twenty-nine yards in length, parallel to the superficies above; it was two and three yards high, and commonly as broad, and alike rocky as

the tunnel, with some appearances of spar, but nothing else in it except a few bats.

"The cavity below was in like manner rocky, and very irregular; the candles and torches burnt clear, so as to discover the whole extent thereof; nor was the air any thing offensive. The three men that went down the first day staid below two hours and a half. The next day the captain went down with seven or eight men, who staid below for an hour, and observed all things.

"The bottom of this hole, where the land-waters gather, is forty-nine yards down from the superficies of the earth, and by good calculation the same bottom is twenty yards above the highest rising of the Severn, and lies into the land about three miles distant from it."

[*Phil. Trans. Abr. Vol.* II. 1682-3.]

SECTION V.

Cavern of Dunmow-Park, near Kilkenny, in Ireland. By Mr. Adam Walker.

THIS cavern is situated in a fine plain, rising indeed here and there into small hills. The country all round abounds with limestone, and quarries of beautiful black marble, variegated with white shells. Different from those of Derbyshire and Mendip, this cave descends perpendicularly thirty yards, from the top of a small hill, through an opening forty yards in diameter. The sides of this pit are lime stone-rock, whose chinks nourish various shrubs and trees, down which the inspector must descend with great caution. In this descent he is amused with flights of wild pigeons, and jackdaws from the cave below. When he reaches the bottom, he sees one side of this pit supported by a natural arch of rock, above twenty-five yards wide, under which he goes horizontally, and sees two subterraneous openings to the right and left. If he turns to the right, he makes his way over rocks and stones, coated with spar in the most whimsical shapes, and formed from the dropping roof, just as the dripping of a candle would cover a pebble. These knobs take a fine polish, are transparent, and variegated with the wildest assemblage of colouring. The Earl of Wandesford had one of them sawn into a slab, and it is as beautiful as a moco. When these petrifactions are tried with an acid, the effervescence is excessively strong; and as the earth all round is calcareous, and the stones limestone, probably the icicle figures depending from the roof, and

these knobs, are thus formed. The rains that fall on the hill over this cavern, oozing through an okery calcareous earth, and the lime-stone roof, imbibe or dissolve their fine particles in their descent; and as this mixture can only filter through the rock exceedingly slow, the water hanging on the roof is soon dissolved by the air, and the stony particles are left behind. Hence are formed the icicle-shaped cones that hang from the roof; these growing perpetually longer, have, in many parts of the cave, met the knobs from the bottom, and formed a number of fantastic appearances, like the pillars of a Gothic cathedral, organs, crosses, &c. When the rain filters pretty fast through the roof, it falls on the rocks below, and grows there into knobs and cones, whose vertex points to those that impend from the roof.

A spectator, viewing these, cannot but conceive himself in the mouth of a huge wild beast, with ten thousand teeth above his head, and as many under his feet. The scene is indeed both pleasing and awful; the candles burning dim, from the moisture in the air, just served to shew a spangled roof perpetually varnished with water, in some places upwards of twenty yards high; in other places they crawled on all-four, through cells that will admit only one at a time. After having scrambled about five hundred yards into this right-hand part of the cave, they returned to day-light, and then proceeded to view the left-hand part. Here were many different branches of the cavern; they tied one ball of packthread to another, as they went forward, that they might more easily find their way back. This branch is not so horizontal as the other; it declines downwards, and the openings in it are vastly wider, some being at least one hundred yards wide, and above fifty high. A small rill accompanied them, which, by its different falls, formed a sort of rude harmony, well suited to the place. In a standing part of this brook, and near a quarter of a mile from the entrance, they found the bones of a hundred at least of the human race; some were very large, but when taken out of the water they crumbled away. As they could find nothing like an inscription, or earth for a burying place, they conjectured that some of the civil wars, perhaps that of 1641, might have driven the owners of these bones into this place. The tradition of the neighbourhood threw no light upon it.

Many of the rocks, on the roof and sides of this cavern, are black marble, full of white spots of a shell-like figure; and the whole

neighbourhood is full of quarries of this beautiful stone, which takes a fine polish, and is used through the three kingdoms for slabs, chimney pieces, &c. In some deep and wet parts of these quarries, this elegant fossil is seen in the first stages of its formation; the shells are real, but so softened by time and their moist situation, as to be susceptible of receiving the stony particles into their pores, by whose cohesive quality, they in time become those hard white curls that give value to the marble: and it is very remarkable, and a proof that these white spots have been real shells, and thus formed, that the longer a chimney-piece or slab is used, the more of those spots ripen into view.

[*Phil. Trans. Abr. Vol.* XIII. 1773.]

SECTION VI.

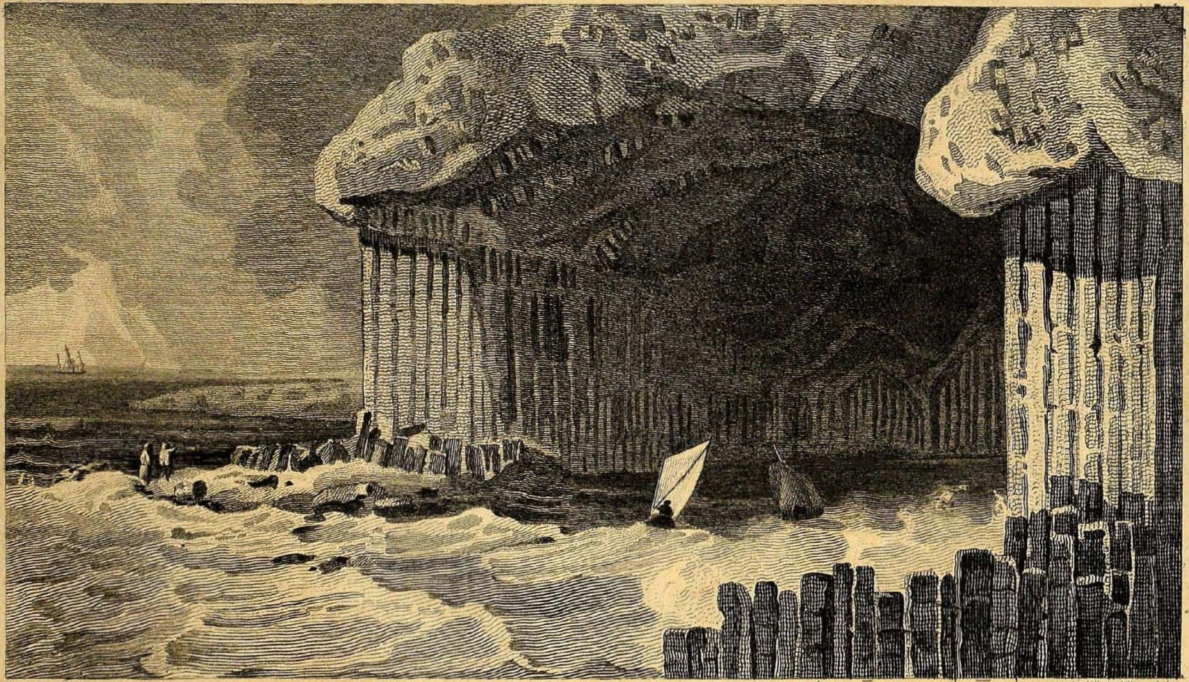
Cave of Fingal.

THIS is the most extraordinary feature of the most extraordinary island of the Hebrides, the whole of it constituting one of the most singular and romantic spots in the world. By far the best description we have received of it has been from the pen of Sir Joseph Banks, which we shall copy, unabridged, into the present section.

"In the sound of Mull, we came to anchor, on the Morven side, opposite to a gentleman's house, called Drumnen; the owner of it, Mr. Macleane, having found out who we were, very cordially asked us ashore; we accepted his invitation, and arrived at his house, where we met an English gentleman. Mr. Leach*, who no sooner saw us than he told us, that about nine leagues from us was an island where he believed no one even in the Highlands had been †, onwhich were pillars like those of the Giants' Causeway: this was a great object to me, who had wished to have seen the causeway itself, would time have allowed; I therefore resolved to proceed directly, especially as it was just in the way to the Columb-kill; accordingly,

*" I cannot but express the obligations I have to this gentleman for his very kind intentions of informing me of this matchless curiosity; for I am informed that he pursued me in a boat for two miles, to acquaint me with what he had observed; but, unfortunately for me, we out-sailed his liberal intention."

† "When I lay in the sound of Jona, two gentlemen, from the isle of Mull, and whose settlements were there, seemed to know nothing of this place; at least they never mentioned it as any thing wonderful."



Engraved by Scott from a Drawing by Clennell. For the Gallery of Nature & Art.

CAVE OF FINGAL,
in the *ISLE* of *STAFFA*.

London: Published by R. Wilks, 89 Chancery Lane, April 1, 1815.

having put up two days provisions, and my little tent, we put off in the boat about one o'clock for our intended voyage, having ordered the ship to wait for us in Tobirmore, a very fine harbour on the Mull side.

"At nine o'clock, after a tedious passage, having had not a breath of wind, we arrived, under the direction of Mr. Macleane's son and Mr. Leach. It was too dark to see any thing, so we carried our tent and baggage near the only house upon the island, and began to cook our suppers, in order to be prepared for the earliest dawn, to enjoy that which from the conversation of the gentlemen we had now raised the highest expectations of.

The impatience which every body felt to see the wonders we had heard so largely described, prevented our morning's rest; every one was up and in motion before the break of day, and with the first light arrived at the south-west part of the island, the seat of the most remarkable pillars; where we no sooner arrived than we were struck with a scene of magnificence which exceeded our expectations, though formed, as we thought, upon the most sanguine foundations; the whole of that end of the island supported by ranges of natural pillars, mostly above fifty feet high, standing in natural collonades, according as the bays or points of land formed themselves upon a firm basis of solid unformed rock, above these, the stratum which reaches to the soil or surface of the island, varied in thickness as the island itself formed into hills or vallies; each hill, which hung over the columns below, forming an ample pediment; some of these above sixty feet in thickness, from the base to the point, formed by the sloping of the hill on each side, almost into the shape of those used in architecture.

Compared to this what are the cathedrals or the palaces built by men! mere models or playthings, imitations as diminutive as his works will always be when compared to those of nature. Where is now the boast of the architect! regularity, the only part in which he fancied himself to exceed his mistress, Nature, is here found in her possession, and here it has been for ages undescribed* Is not

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* Staffa is taken notice of by Buchanan, but in the slightest manner; and among the thousands who have have navigated these seas, none ever paid the least attention to its grand and striking characteristic, till the present writer.

This island is the property of Mr. Lauchlan Mac Quaire, of Ulva, and is now to be disposed of.

this the school where the art was originally studied, and what has been added to this by the whole Grecian school? a capital to ornament the column of nature, of which they could execute only a model; and for that very capital they were obliged to a bush of Acanthus: how amply does nature repay those who study her wonderful works!

With our minds full of such reflections we proceeded along the shore, treading upon another Giant's Causeway, every stone being regularly formed into a certain number of sides and angles, till in a short time we arrived at the mouth of a cave, the most magnificent, I suppose, that has ever been described by travellers.

The mind can hardly form an idea more magnificent than such a space, supported on each side by ranges of columns; and roofed by the bottoms of those, which have been broke off in order to form it; between the angles of which a yellow stalagmitic matter has exuded, which serves to define the angles precisely; and at the same time vary the colour with a great deal of elegance, and to render it still more agreeable, the whole is lighted from without; so that the farthest extremity is very plainly seen from without, and the air within, being agitated by the flux and reflux of the tides, is perfectly dry and wholesome, free entirely from the damp vapours with which natural caverns in general abound.

We asked the name of it. Said our guide, The cave of Fhinn. What is Fhinn? said we. Fhinn Mac Coul, whom the translator of Ossian's works has called Fingal. How fortunate that in this cave we should meet with the remembrance of that chief, whose existence, as well as that of the whole epic poem, is almost doubted in England.

Enough for the beauties of Staffa; I shall now proceed to describe it and its productions more philosophically.

The little island of Staffa lies on the west coast of Mull, about three leagues north-east from Jona, or the Columb-kill; its greatest length it about an English mile, and its breadth about half a one. On the west side of the isle is a small bay, where boats generally land; a little to the southward of which the first appearance of pillars are to be observed; they are small, and instead of being placed upright, lie down on their sides, each forming a segment of a circle; from thence you pass a small cave, above which, the pillars, now grown a little larger, are inclining in all directions: in one place in particular a small mass of them very much resemble the ribs of a ship*; from

* The Giant's Causeway has its bending pillars; but I imagine them to be very different from these. Those I saw were erect, and ran along the face of a

hence, having passed the cave, which, if it is not low water, you must do in a boat, you come to the first ranges of pillars, which are still not above half as large as those a little beyond. Over against this place is a small island, called in Erse, Boo-sha-la, or more properly, Buacha-ille, or the herdsman, separated from the main by a channel not many fathoms wide; this whole island is composed of pillars without any stratum above them; they are still small, but by much the neatest formed of any about the place.

The first division of the island, for at high water it is divided into two, makes a kind of a cone, the pillars converging together towards the centre; on the other, they are in general laid down flat, and in the front next to the main, you see how beautifully they are packed together, their ends coming out square with the bank which they form: all these have their transverse sections exact, and their surfaces smooth, which is by no means the case with the large ones, which are cracked in all directions. I much question, however, if any one of this whole island of Buachaille is two feet in diameter.

The main island opposed to Boo-sha-la and farther towards the north-west is supported by ranges of pillars pretty erect, and, though not tall, (as they are not uncovered to the base,) of large diameters; and at their feet is an irregular pavement made by the upper sides of such as have been broken off, which extends as far under water as the eye can reach. Here the forms of the pillars are apparent: these are of three, four, five, six, and seven sides, but the numbers of five and six are by much the most prevalent. The largest I measured was of seven; it was four feet five inches in diameter. I shall give the measurement of its sides and those of some other form which I met with.

No. 1. 4 sides, diam. 1 ft. 5 in. No. 2. 5 sides, diam. 2 ft. 10 in

	Ft.	In.
Side 1.	1	5
2.	1	1
3.	1	6
4.	1	1

	Ft.	In
Side 1.	1	10
2.	1	10
3.	1	5
4.	1	$7\frac{1}{2}$
5.	1	8

high cliff, bent strangely in their middle, as if unable, at their original formation, while in a soft state, to support the mass of incumbent earth that pressed on them.

No. 3. 6 sides, diam. 3 ft. 6 in. No. 4. 7 sides, diam. 4 ft. 5 in.

	Ft.	In.
Side 1.	0	10
2.	2	2
3.	2	2
4.	1	11
5.	2	2
6.	2	9

	Ft.	In.
Side 1.	2	10
2.	2	4
3.	1	10
4.	2	0
5.	1	1
6.	1	6
7.	1	3

The surfaces of these large pillars in general are rough and uneven, full of cracks in all directions: the transverse figures in the upright ones never fail to run in their true directions; the surfaces upon which we walked were often flat, having neither concavity nor convexity; the larger number, however, were concave, though some were very evidently convex; in some places the interstices within the perpendicular figures were filled up with a yellow spar; in one place a vein passed in among the mass of pillars, carrying here and there small threads of spar. Though they were broken and cracked through and through in all directions, yet their perpendicular figures might easily be traced; from whence it is easy to infer, that whatever the accident might have been that caused the dislocation, it happened after the formation of the pillars.

From hence, proceeding along shore, you arrive at Fingal's Cave: its dimensions, though I have given, I shall here again repeat in the form of a table:

	Ft.	In.
Length of the cave from the rock without -	371	6
from the pitch of the arch -	250	0
Breadth of ditto at the mouth - - -	53	7
at the farther end - -	20	0
Height of the arch at the mouth - - -	117	6
at the end - - -	70	0
Height of an outside pillar - - - -	39	6
of one at the N. W. corner - - -	54	0
Depth of water at the mouth - - -	18	0
at the bottom - - -	9	0

The cave runs into the rock in the direction of N. E. by E. by the compass.

Proceeding farther to the N. W. you meet with the highest

ranges of pillars, the magnificent appearance of which is past all description: here they are bare to their very basis, and the stratum below them is also visible; in a short time it rises many feet above the water, and gives an opportunity of examining its quality. Its surface rough, and has often large lumps of stone sticking in it, as if half immersed; itself, when broken, is composed of a thousand heterogeneous parts, which together have very much the appearance of a lava; and the more so, as many of the lumps appear to be of the very same stone of which the pillars are formed; this whole stratum lies in an inclined position, dipping gradually towards the S.E. As hereabouts is the situation of the highest pillars, I shall mention my measurements of them, and the different strata in this place, premising that the measurements were made with a line, held in the hand of a person who stood at the top of the cliff, and reaching to the bottom, to the lower end of which was tied a white mark, which was observed by one who staid below for the purpose; when this mark was set-off from the water, the person below noted it down, and made signal to him above, who made then a mark in his rope: whenever this mark passed a notable place, the same signal was made, and the name of the place noted down as before; the line being all hauled up, and the distances between the marks measured and noted down, gave, when compared with the book kept below, the distances, as for instance in the cave:

No. 1. in the book below, was called from the water to the foot of the first pillar, in the book above; No. 1. gave 36 feet 8 inches, the highest of that ascent, which was composed of broken pillars.

No. 1. Pillar at the west corner of Fingal's cave;

	Ft.	In.
1. From the water to the foot of the pillar -	12	10
2. Height of the pillar - - -	37	3
3. Stratum above the pillar - - -	66	9

No. 2. Fingal's cave;

1, From the water to the foot of the pillar -	36	8
2. Height of the pillar - - -	39	6
3. From the top of the pillar to the top of the arch	31	4
4. Thickness of the stratum above - -	34	4
By adding together the three first measurements, we got the height of the arch from the water -	117	6

No. 3. Corner pillar to the westward of Fingal's cave:

	Ft.	In.
Stratum below the pillar of lava-like matter -	11	0
Length of pillar - - - -	54	0
Stratum above the pillar - - -	61	6

No. 4. Another pillar to the westward:

	Ft.	In.
Stratum below the pillar - - -	17	1
Height of the pillar - - - -	50	0
Stratum above - - - -	51	1

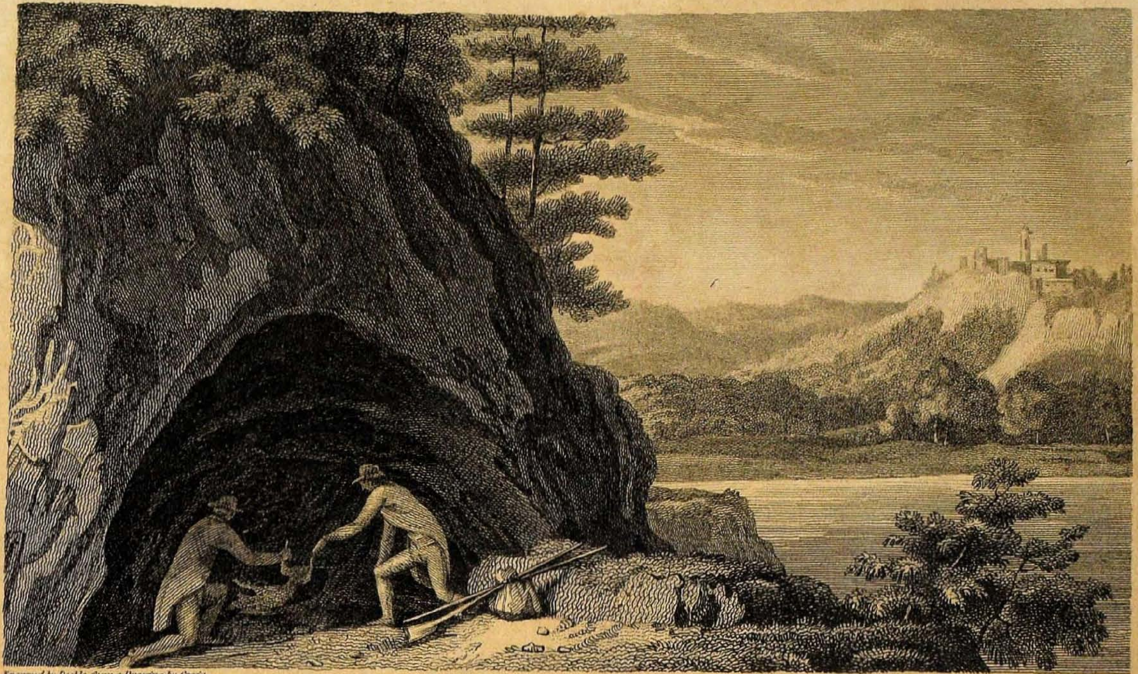
No. 5. Another pillar farther to the westward:

	Ft.	In.
Stratum below the pillar - - -	19	8
Height of the pillar - - -	55	1
Stratum above - - - -	54	7

The stratum above the pillars, which is here mentioned, is uniformly the same, consisting of numberless small pillars, bending and inclining in all directions, sometimes so irregularly, that the stones can only be said to have an inclination to assume a columnar form; in others more regular, but never breaking into, or disturbing the stratum of large pillars, whose tops keep every where an uniform and regular line.

Proceeding now along shore round the north end of the island, you arrive at Oua-na-scarve, or the Corvorant's Cave: here the stratum under the pillars is lifted up very high; the pillars above it are considerably less than those at the N. W. end of the island, but still very considerable. Beyond is a bay, which cuts deep into the island, rendering it in that place not more than a quarter of a mile over. On the sides of this bay, especially beyond a little valley, which almost cuts the island into two, are two stages of pillars, but small; however, having a stratum between them exactly the same as that above them, formed of innumerable little pillars, shaken out of their places, and leaning in all directions.

Having passed this bay, the pillars totally cease; the rock is of a dark-brown stone, and no signs of regularity occur till you have passed round the S. E. end of the island, (a space almost as large as that occupied by the pillars, which you meet again on the west side, beginning to form themselves irregularly, as if the stratum



Engraved by Deeble, from a Drawing by Craig. For the Gallery of Nature & Art.

GROTTO DEL CANE, ON THE LAKE OF AGNANO, IN ITALY.

London, Published by R. Wilks, 89, Chancery Lane, Sep. 1, 1814.

had an inclination to that form, and soon arrive at the bending pillars where I began.

The stone of which the pillars are formed is a coarse kind of basaltes, very much resembling the Giant's Causeway in Ireland, though none of them are near so neat as the specimens of the latter, which I have seen at the British Museum; owing chiefly to the colour, which in ours is a dirty brown, in the Irish a fine black: indeed the whole production seems very much to resemble the Giant's Causeway; with which I should willingly compare it, had I any account of the former before me*.

SECTION VII.

Grotta del Cane †.

THERE is no person conversant with literature who does not know that this name has been given to a small cavern between Naples and Pozzuolo, because if a dog be brought into it, and his nose held to the ground, he soon begins to breathe with difficulty, and loses all sense, and even life, if he be not speedily removed into the open and purer air. This grotto, though so celebrated both in ancient and modern times, in fact shares its fame with several other places which are endowed with the same deleterious quality; as it is only one of the almost innumerable pestiferous vapours in different parts of the world, especially in volcanic countries, which are quickly fatal both to brute animals and man, though they do not offer to the eye the slightest indication of their presence. They have been mentioned by a numerous list of writers, whom I might cite, were I disposed to make an unseasonable parade of my reading. It is to be remarked that the greater part of these vapours are only temporary, whereas that of the Grotta del Cane is perpetual, and seems to have produced its deadly effects in the time of Pliny. A man standing erect suffers nothing from it; as the mephitic vapour rises only to a

* Staffa is a genuine mass of basaltes, or Giant's Causeway; but in most respects superior to the Irish in grandeur. The name is Norwegian; and most properly bestowed on account of its singular structure; Staffa being derived from Staf, a staff, prop, or, figuratively, a column.

† For the Grotto di Posilipo, which is an artificial excavation, see Part III. of this work.

small height from the ground; I, therefore, entered it without danger; but notwithstanding the most attentive observation I could make, I could not perceive the smallest visible exhalation.

It therefore appeared to me that M. Ferber must have been mistaken, when he says, "the killing damps rise from the ground, about a palm above the floor, move along it as a white smoke, and spread through the door in the open air.*" But, as it has already been observed that the smoke of a torch extinguished in the vapour sinks downwards, assumes a whitish colour, and goes out at the bottom of the door; it appears probable that this occasioned his mistake, especially as he mentions the experiment of the extinguished torch in the same place.

As little can I agree with him that the mischievous effects of this vapour are the consequence of the air being deprived of its elasticity †; since it has been demonstrated that they are to be attributed to the carbonic-acid gas, as was first proved by M. Adolphus Murray. As we know, likewise, that a candle being extinguished in this gas, the fumes which proceed from it mix more readily with the gas than with the atmospheric air; we perceive why the smoke of a torch which ceases to burn in the Grotta del Cane, sinks where the pestiferous vapour is strongest, and, passing along the ground, goes out at the lower part of the door.

The person who is the keeper, or guide, at the grotto, and who shews to strangers the experiment of the dog for a gratuity, when the animal is panting, and half dead, takes him into the open air, and afterwards throws him into the neighbouring lake of Agnano; insinuating that this short immersion into the water is necessary completely to restore him. M. Ferber relates this fact, and shews that he believed all that was told him concerning it. The truth however is, that the plunging the dog into the lake is a mere trick, to render the experiment more specious, and obtain money from the credulous, as the atmospheric air alone is sufficient to restore the animal to life.

The experiments made by M. Murray, to ascertain the nature of this mephitic vapour, have discovered to us what was before un-

* Ferber's Travels through Italy, p. 146, of the English translation.
† Ferber's Travels.

known, and we owe to him every grateful acknowledgment. They have not, however, explained every thing we could wish to learn relative to this cavern. Whoever is versed in the knowledge of nature, and acquainted, in any degree, with the difficult art of making experiments, must be convinced what a number of these might be made in it, which would greatly tend to throw new light on physiology and physics. I conceived a strong desire to attempt several, and communicated my intention to the Abbé Breislak, who accompanied me to the Grotta del Cane. We agreed to divide them between us, that I should apply myself to the physiological, or those which had for their object living beings, and he bestow his attention to the physical. As I was on the point of setting out for Sicily, I resolved to carry this plan into execution on my return to Naples. But Mount Etna and the Lipari isles detained me a long time; and when I returned I had scarcely time to visit Vesuvius, being obliged to repair almost immediately to Padua, to begin my public lectures in Natural History. My friend, the abbé, however, who resides constantly near Solfatara, in consequence of his superintendence of the works there, proceeded, after my departure, to fulfil the task I had assigned him, and communicated to me the result of his experiments in a letter, which, with his consent, I here publish, as I am convinced that it will be highly gratifying to my readers.

"NAPLES, *November* 20, 1790.

"RESPECTABLE FRIEND,

"When you visited this city, two years ago, to make observations on the Phlegrean Fields, you did me the honour to propose to me to assist you in making a regular series of experiments on the celebrated mephitic vapour of the Grotta del Cane. You may remember that we agreed to divide between us the objects to be examined. You proposed to inquire in what manner the exhalation acts on the animal economy, so as first to suspend its functions, and at last totally destroy them, unless the means of restoration are speedily applied. This problem, though considered by many, has never been investigated with that precision and accuracy which it deserves, nor have experiments been sufficiently multiplied and diversified to establish a general law. From you I expected that it would have received new light, accustomed as you are to develop the most complicated arcana of nature. In the experiments to be

made, you reserved to yourself the physiological, leaving to me the physico-chemical. Your journey into Sicily, and your hasty return to Padua, to exercise the duties of your professorship, rendered it impossible at that time for you to execute your part of the plan. I have not dared to treat a subject reserved for you, but I hope that some other, to me fortunate, combination of circumstances may once more bring you back to Naples, and afford you an opportunity to prosecute these inquiries, together with others analogous to them. In the mean time, in some excursions which I have made to the lake Agnano, I have examined, with the utmost attention, this little grotto; and have made several experiments, by the detail of which I doubt not but you will be gratified. The subject, it is true, has been repeatedly examined by many naturalists, both natives of Italy and foreigners; but their success has not been sufficient to preclude every new experiment.

" The mephitic vapour, as you well know, occupies the floor of a small grotto near the lake Agnano, a place highly interesting to naturalists from the phænomena its environs present, and the hills within which it is included. This grotto is situated on the south-east side of the lake, at a little distance from it. Its length is about twelve feet, and its breadth from four to five. It appears to have been originally a small excavation, made for the purpose of obtaining puzzolana. In the sides of the grotto, among the earthy volcanic matters, are found pieces of lava, of the same kind with those we meet with scattered near the lake. I examined some of them, and found them a compact lava, of a deep grey colour, interspersed with small hexaedrous prisms of mica. They are of an earthy grain, a micaceous consistence, and have a sensible effect on the magnet. Particles of feltspar are rarely found in them, and we meet with no specimens which contain shoerls. I am persuaded that were new excavations made in the vicinity of the grotto, at a level with its floor, or a little lower, the same mephitic vapour would be found, and it certainly would be curious to ascertain the limits of its extent. It would likewise be extremely advantageous for physical observations, were the grotto somewhat enlarged, and its floor reduced to a level horizontal plain, by lowering it two or three feet, and surrounding it by a low wall, with steps at the entrance. In its present state, it is extremely inconvenient for experiments, and the inclination of the ground towards the door causes a great part of the

vapour, from the effect of its specific gravity, to make its way out close to the ground. When I consider the narrow limits of this place, and the small quantity of the vapour which has rendered it so celebrated, I have no doubt but it must have undergone considerable changes; for it does not appear probable to me that Pliny meant only the present confined vapour, when (lib. ii. cap. 93) enumerating many places from which a deadly air exhaled, he mentions the territory of Pozzuolo. The internal fermentations by which it is caused are certainly much diminished in the vicinity of the lake Agnano. The water near its banks is no longer seen to bubble up, from the disengagement of a gas, as we learn that it formerly did, from accounts of no very great antiquity. I have attentively examined the borders of the lake, when its waters were at the highest, and after heavy rains, but I never could discover a single bubble of air. A number of aquatic insects, which sport on the surface, may, at first view, occasion some deception; but a little observation will detect the error. If we do not suppose those authors who have described the ebullition of the water near the banks of the lake Agnano to have been deceived, we must at least confess that this phenomenon has now ceased. The quantity of the hepatic vapours, which rise in the contiguous stoves, called the stoves of St. Germano, must likewise be greatly diminished from what it anciently was: for, adjoining to the present stoves, we still find the remains of a spacious ancient fabric, with tubes of terra cotta inserted in the walls, which, by their direction, shew for what purpose they were intended. It appears certain, that this was a building in which, by the means of pipes properly disposed, the vapours of the place were introduced into different rooms, for the use of patients, who were accommodated there in a much better manner than they are in the modern stoves of St. Germano, which wretched places nothing could induce them to endure but the hope of being restored to health. To these ruins, however, the vapours no longer extend; so that, if this edifice still remained, it could not be employed for the purpose for which it was intended. The veins of pyrites which have produced the more ancient conflagrations of the Phlegrean fields, between Naples and Cuma, and which in some places, are entirely consumed, approach their total extinction. But let us proceed to the experiments made, and frequently repeated, within the grotto.

"I. The first had for its object to determine the height of the

mephitis, at the centre of the grotto, that is, at the intersection of the line of its greatest length with that of its greatest breadth. This height varies according to the different dispositions and temperatures of the atmosphere, the diversity of winds, and the accidental variations that take place in the internal fermentations by which the vapour is produced; it may, however, be estimated, at a mean, at eight Paris inches.

"II. The entrance into the mephitis is accompanied with a slight sensation of heat, in the feet and lower part of the legs. When, in the year 1786, I visited the larger mephitic vapours of Latera, in the duchy of Castro, I likewise observed that they produced the sensation of heat in the part of the body which was encompassed by the mephitic atmosphere. Yet on taking out of the vapour several substances which had remained in it a long time, as stones, leaves, carcases of animals, &c. I found that these were of the same temperature with the atmospheric air; but as I had broken my thermometer on the road, and was unable to procure another in any of the places through which I passed, I could not ascertain the temperature of the mephitis. I felt in my body a slight degree of heat, which I could not perceive in the substances I took out of the mephitic vapour; and endeavouring to compare one thing with another, I concluded that the temperature of the mephitis was the same with that of the atmospheric air, which I attempted to explain to myself on the principles laid down by Dr. Crawford. But a number of other experiments, made in the Grotta del Cane, have convinced me that this exhalation has a distinct degree of heat, different from that of the atmosphere. In these experiments, which I repeated many times, the thermometer, suspended at the aperture of the grotto, three feet above the surface of the mephitis, stood at between 13 and 14 of Reaumur's scale (62 and 64 of Fahrenheit's); and, placing the ball on the ground; so that it was immersed in the mephitic vapour, the mercury rose to between 21 and 22 of Reaumur (80 and 82 of Fahrenheit). Nor ought it to excite surprise, that the substances taken out of the mephitis did not exhibit this diversity of temperature, both because the difference is small, and on account of the quantity of humidity with which they are always loaded, and which produces on their surface a continual evaporation. I frequently repeated this experiment, making use of different thermometers, because I knew that the celebrated M. Adolphus Murray,

when he made his experiments in the Grotta del Cane, had not observed the vapour to produce any effect on the mercury in the thermometer.

"III. I repeated, for my own satisfaction, the usual experiments, made by many naturalists, when the tincture of turnsole, lime-water, the crystallizations of alkalis, the absorption of water, and the acidulous taste communicated to it, which prove beyond all doubt the existence of fixed air, or carbonic acid, in the exhalation of which we treat. But is it composed of fixed air alone? This I wished to ascertain. When exposed in a eudiometer to nitrous gas, an absorption took place, to about the $\frac{10}{100}$ of the quantity. In a phial filled with this air, and continued with the mouth immersed in water for fifteen days, the water slowly rose till it occupied $\frac{40}{100}$: it may, therefore, be concluded that the relative quantities of the different gases which compose the mephitic air of the Grotta del Cane are as follows: $\frac{10}{100}$ of vital air, or oxygenous gas, $\frac{40}{100}$ of fixed air, or carbonic acid, and $\frac{50}{100}$ of phlogisticated air, or azotic gas; or perhaps it is a mixture of carbonic acid and atmospheric air, with a small quantity of azotic gas, more than is contained in the atmospheric air.

"The vicinity of the grotto to the stoves of Agnano, the warm vapours of which contain a considerable quantity of hydrogenous sulphurated gas, induced me to suspect that some portion of the latter might be found mixed with the gas of the mephitis; but I was not able to discover in it the smallest quantity. I made use of the sugar of lead, or acetite of lead, which, as you well know, is extremely sensible to the slightest impression of hepatic gas, leaving it immersed in the mephitis for the space of half an hour.

"It is certainly a curious problem to investigate the origin of this fixed air. You are acquainted with the different opinions of naturalists, some of whom consider it as atmospheric air, changed into fixed by the action of the electric matter of the lava; while others suppose it produced by a slow and successive decomposition of the calcareous earth, effected, either by a subterraneous fire, or by an acid. But the fact is, that in the Grotta del Cane, there is not a single vein of lava, and that the atmosphere of that vicinity exhibits no particular signs of electricity. The hypothesis founded on the decomposition of the calcareous earth, is, likewise, subject to great difficulties. Our excellent common friend, the Pane-

gyrist of Dolomieu, in his valuable Notes to the Dissertations of Bergman on the products of volcanoes, is of opinion, that the fixed air of volcanic places is produced by the re-action of the sulphur on the calcareous earth, with which it forms a liver of earthy sulphur. I am rather inclined to believe that the fixed air of volcanized countries is not developed ready formed from any substance, but is the produce of the plumbago contained in the iron, with which all volcanic substances abound, combined with the base of vital air afforded by the internal decompositions of the pyrites. I am not induced to embrace this system by its novelty. The experiments of Messieurs Lavoisier, Berthollet, Mongez, Landriani, and many other excellent chemists, compared with local observations, have proved, beyond a doubt, the existence of plumbago in iron. It is certain that all volcanic substances abound in iron, and the hepatic vapours which rise in the stoves of St. Germano, in the vicinity of the Grotta del Cane, prove the internal decomposition of the pyrites, which still takes place here: a decomposition, which, by giving birth to the mephitic acid, furnishes likewise the base of vital air.

"IV. Among the notices which the celebrated Bergman wished to receive, relative to the Grotta del Cane, he desired a detail of the phænomena of magnetism and electricity. With respect to the former, I have observed no new appearance. The magnetic needle, placed on the ground, and consequently immersed in the mephitis, rested in the direction of its meridian; and, at the approach of a magnetized bar, exhibited the usual effects of attraction and repulsion, according as either pole was presented. With regard to the latter article, it is not possible to make electrical experiments, within the mephitis; not because that kind of air is a conductor of the electric fluid, as M. Murray imagined, but because the humidity that constantly accompanies it, disperses the electric matter, which not being collected in a conductor, cannot be rendered sensible. I several times attempted to fire inflammable gas, in the mephitic vapour, with electric sparks by means of the conductor of the electrophorus; but, notwithstanding my utmost endeavours to animate the electricity, I never could obtain a single spark; as the non-conductor became a conductor the moment it entered into the mephitis, on account of the humidity which adhered to its surface.

"V. One of the principal objects of the researches of academies and naturalists, at present, is the theory of the combustion of

bodies. My first experiment was directed to ascertain whether those spontaneous inflammations which result from the mixture of concentrated acids with essential oils could be obtained. I placed on the ground, in the grotto, a small vessel, in such a situation that the mephitis rose six inches above the edges of the vessel. I made use of oil of turpentine, and the vitriolic and nitrous acids, and the same inflammation followed, accompanied with a lively flame, as would have taken place in the open atmospheric air. The dense smoke, which always accompanies these inflammations, attracted by the humidity of the mephitis, presented its undulations to the eye, and formed a very pleasing object. As I had put a considerable quantity of acid in the vessel, I repeatedly poured in a little of the oil, and the flame appeared in the mouth of the vessel fifteen times successively. The oxygenous principle, contained in the acids, and with which the nitrous acid principally abounds, undoubtedly contributed to the production and duration of this flame, though enveloped in an atmosphere inimical to inflammation.

"In the district of Latera, which I have mentioned above, I observed that, in a mephitis of hydrogenous sulphurated or hepatic gas, a slow combustion of phosphorous took place, with the same resplendence as in the atmospheric air. As I had not with me a sufficient quantity of phosphorus, I could not proceed farther with this experiment, nor vary it as might have been necessary. In the mephitis of Agnano, the first experiment I made was with common phosphoric matches, of which I broke five, holding them close to the ground, and consequently immersed in the mephitis. They all produced a short and transient flame, which became extinguished the moment it was communicated to the wick of a candle. The second experiment I made was the following. I placed on the ground, in the grotto, a long table, in such a manner that one end of it was without the mephitis, while the other, and four fifths of its whole length, were immersed in it. Along this table I laid a train of gunpowder, beginning from the end without the mephitis; and, at the other, which was immersed in it, the depth of seven inches, I placed, adjoining to the gunpowder, a cylinder of phosphorus, eight lines in length. The gunpowder without the mephitis being fired, the combustion was soon communicated to the other extremity of the train, and to the phosphorus, which took fire with decrepitation, burnt rapidly, with a bright flame, slightly coloured

with yellow and green, and left on the wood a black mark, as of charcoal. The combustion lasted nearly two minutes, till the whole phosphoric matter was consumed.

" I then proceeded to another experiment. I placed some gunpowder on the ground in the grotto; and having lighted a cylinder of phosphorus without the mephitis, I immerged it within it, while burning, carried it the distance of ten feet, and threw it on the gunpowder, which immediately took fire. No alteration was perceptible in the flame, or manner of burning, of the lighted phosphorus, either at the moment of its entrance into the mephitis, or during its continuance in it.

" I afterwards lighted another cylinder of phosphorus, and conveyed it immediately into the mephitis, supporting it with a small piece of wood; and this likewise burnt briskly until it was entirely consumed.

" It may, perhaps, be suspected that, in the experiments with gunpowder, the oxygenous gas contained in the nitre, co-operated to the combustion of the phosphorus; but it is certain that, independent of the nitre, this curious substance, though it burnt in mephitic air, presented the same appearances as in the atmospheric air. I am aware that, among the experiments of M. Lavoisier, there is one on the combustion of phosphorus produced by means of a burning mirror, under a glass bell, the mouth of which was immersed in mercury. That excellent naturalist observed that the phosphorus began to burn, but that, in a few moments, the air of the receiver being no longer proper to nourish the combustion, it became extinguished. Is it not probable that the extinction of the phosphorus did not proceed from the infection of the air, but that the vapours of the phosphoric matter remaining confined in the receiver, and condensing around the phosphorus, suffocated its flame? he mephitic gas of the Grotta del Cane is certainly unfit for the respiration of animals, and the inflammation of common combustible substances; but phosphorus, nevertheless, burns it, and emits, as usual, luminous sparks.

" I must not conclude without noticing the production of the phosphoric acid from the slow combustion of phosphorus in the mephitis. Perhaps this may present particular modifications, dependent on the carbonic acid, to which it must necessarily unite itself in this situation. But I have not yet been able to prosecute

this experiment, the temperature of the place not being such as is requisite to make use of the apparatus suited to the method of M. Sage.

[*Spalanzani.*]

SECTION VIII.

Subterraneous Quarries at Paris *.

CONCERNING the origin of these extraordinary excavations there is no small degree of doubt, nor do we know in the present day whether they are better entitled to the character of a natural or of an artificial production. It is probable, however, that they partake of both, and that art has completed what nature was found to have commenced; and we have hence allotted them a place in the present division of our work. The best account we have received of them is the following of Mr. White, which we shall offer without abridgment.

PARIS, *July* 29, 1784.

I Yesterday visited a most extraordinary subterraneous cavern, commonly called the Quarries. But before I give you the history of my expedition it will perhaps be necessary to say a few words concerning the Royal Observatory, the place of descent into this very remarkable cavern. This edifice is situated in St. James's suburbs, in the highest part of the city. It takes its name from its use, and was built by Louis XIV. in 1667, after the design of Claude Perrault, member of the Academy of Sciences, and first architect to his majesty. It serves for the residence of mathematicians, appointed by the king to make observations, and improve astronomy. The mode of building it is ingenious, and admirably contrived, it being so well arched that neither wood nor iron are employed in its construction. All the stones have have been well chosen, and placed with an uniformity and equality which contribute much to the beauty and solidity of the whole edifice. It is reckoned to be about eighty or ninety feet in height, and at the top

* See, for similar subcavations at Whitehaven in Cumberland, chapter xxviii. section vii.

there is a beautiful platform, paved with flint stones, which commands an excellent view of Paris and its environs. In the different floors of this building, there are a number of trap-doors, placed perpendicularly over each other, and, when these are opened, the stars may be very clearly distinguished, from the bottom of the cave at noon day.

At this place, I was introduced to one of the inspectors (persons appointed by the king to superintend the workmen) by my friend Mr. Smeathman, who had used great application and interest for permission to inspect the quarry, and had been fortunate enough to obtain it. For as this cavern is extended under a great part of the city of Paris, and leaves it in some places almost entirely without support, the inspectors are very particular as to shewing it, and endeavour to keep it as secret as possible, lest, if it should get generally known, it might prove a source of uneasiness and alarm to the inhabitants above. For, what is very remarkable, notwithstanding the extent of this quarry, and the apparent danger many parts of the city are in from it, few, even of those who have constantly resided at Paris, are at all acquainted with it, and on my mentioning the expedition I was going to undertake to several of my Parisian friends, they ridiculed me upon it, and told me, it was impossible there could be any such place.

About nine o'clock in the morning we assembled to the number of forty, and with each a wax candle in his hand, precisely at ten o'clock, descended, by steps, to the depth of three hundred and sixty feet perpendicular. We had likewise a number of guides with torches, which we found very useful; but, even with these assistants, we were several times under the necessity of halting, to examine the plan the inspectors keep of these quarries, that we might direct our course in the right road. I was disappointed in not being able to obtain one of these plans, which would have given the clearest idea of this most extraordinary place. At the entrance the path is narrow for a considerable way; but soon we entered the large and spacious streets, all marked with names, the same as in the city; different advertisements and bills were found, as we proceeded, pasted on the walls, so that it had every appearance of a large town, swallowed up in the earth.

The general height of the roof is about nine or ten feet, but in some

parts not less than thirty, and even forty. In many places there is a liquor continually dropping from it, which congeals immediately, and forms a species of transparent stone, but not so fine and clear as rock crystal. As we continued our peregrination, we thought ourselves in no small danger from the roof, which we found but indifferently propped in some places with wood much decayed. Under the houses, and many of the streets, however, it seemed to be tolerably secured by immense stones set in mortar; in other parts, where there are only fields or gardens above, it was totally unsupported for a considerable space, the roof being perfectly level, or a plane piece of rock.

After traversing about two miles, we again descended about twenty steps, and here found some workmen, in a very cold and damp place, propping up a most dangerous part, which they were fearful would give way every moment. We were glad to give them money for some drink, and make our visit at this place as short as possible. The path here is not more than three feet in width, and the roof so low, that we were obliged to stoop considerably.

By this time several of the party began to repent of their journey, and were much afraid of the damp and cold air we frequently experienced. But, alas! there was no retreating.

On walking some little distance farther, we entered into a kind of salon, cut out of the rock, and said to be exactly under St. James's church. This was illuminated with great taste, occasioned an agreeable surprise, and made us all ample amends for the danger and difficulty we had just before gone through. At one end was a representation in miniature of some of the principal forts in the Indies, with the fortifications, draw-bridges, &c. Cannons were planted, with a couple of soldiers to each, ready to fire. Centinels were placed at different parts of the garrison, particularly before the governor's house; and a regiment of armed men was drawn up in another place, with their general in the front. The whole was made up of a kind of clay which the place affords, was ingeniously contrived, and the light that was thrown upon it, gave it a very pretty effect.

On the other side of this hall, was a long table set out with cold tongues, bread and butter, and some of the best Burgundy I ever drank. Now every thing was hilarity and mirth; our fears were entirely dispelled, and the danger we dreaded the moment before, was now no longer thought of. In short, we were all in good spirits

again, and proceeded on our journey about two miles farther, when our guides judged it prudent for us to ascend, as we were then got to the steps which lead up to the town. We here found ourselves safe at the Val de Grace, near the English benedictine convent, without the least accident having happened to any one of the party. We imagined we had walked about two French leagues, and were absent from the surface of the earth, betwixt four and five hours.

After we had thanked the inspectors and guides for their very great civility, politeness, and attention, we took our leave to visit the English benedictines convent, in whose court-yard, and within a few yards of their house, the roof of the subterraneous passage had given way, and fallen in, the depth of one hundred and ninety-three feet.

Though there were some little danger attending our rash expedition (as some people were pleased to term it), yet it was most exceedingly agreeable, and so perfectly a novel scene, that we were all highly delighted, and thought ourselves amply repaid for our trouble.

I regretted much that I did not take a thermometer and barometer down with me, that I might have had an opportunity of making some remarks on the temperature and weight of the air. Certainly, however, it was colder at this time than on the surface of the earth. But Mr. Smeathman informed me, that when he descended the last winter, in the long and hard frost, he found the air much more temperate than above ground, but far from warm. Neither, however, had he a thermometer with him. I lamented too that I had not time to make more remarks on the petrefactions, &c.

Mr. Smeathman observed, that when he descended, he found a very sensible difficulty of breathing in some of the passages and caverns, where the superincumbent rock was low, and the company crowded. This no doubt was much increased by the number of persons and of wax-lights, but he does not apprehend that the difficulty would have been so great in rooms of equal dimensions above ground. We remarked too, when we descended, that there was, in some degree, an oppression of respiration throughout the whole passage.

There were formerly several openings into the quarries, but the two I have mentioned, viz. the Observatory, and the Val de Grace, are, I believe, the only ones left; and these the inspectors keep con-

stantly locked, and rarely open them, except to strangers particularly introduced, and to workmen who are always employed in some part by the king.

The police thought it a necessary precaution to secure all the entrances into this cavern, from its having been formerly inhabited by a famous gang of robbers, who infested the country for many miles round the city of Paris.

As to the origin of this quarry, I could not, on the strictest en-enquiry, learn any thing satisfactory; and the only account I know published, is contained in the Tableaux de Paris, tom premier, chap. v. p. 12.

" For the first building of Paris, it was necessary to get the stone in the environs, and the consumption of it was very considerable. As Paris was enlarged, the suburbs were insensibly built on the ancient quarries, so that, all that you see without is essentially wanting in the earth, for the foundation of the city: hence proceed the frightful cavities, which are at this time found under the houses in several quarters. They stand upon abysses. It would not require a very violent shock to throw back the stones to the place from whence they have been raised with so much difficulty. Eight men being swallowed up in a gulph one hundred and fifty feet deep, and some other less known accidents, excited at length the vigilance of the police and the government, and, in fact, the buildings of several quarters have been privately propped up; and by this means, a support given to these obscure subterraneous places, which they before wanted.

" All the suburbs of St. James's, Harp-street, and even the street of Tournon, stand upon the ancient quarries; and pillars have been erected to support the weight of the houses. What a subject for reflections, in considering this great city formed, and supported by means absolutely contrary! These towers, these steeples, the arched roofs of these temples are so many signs to tell the eye, that what we now see in the air, is wanting under our feet."

[*Memoirs of the Manchester Society, Vol. II.*]

CHAP. XXVI.

MOSSES, MOORS, BOGS, AND THE PRODUCTION OF PEAT.

SECTION I.

Introductory Remarks.

THE great abundance in the colder parts of the earth of vegetable quagmires or mosses, so denominated from the class of plants of which they chiefly consist, and the rapidity with which under certain circumstances they are renewed, while in the torrid zone they are totally wanting, are circumstances claiming the close attention of geologists. Pit-coal, in like manner, abounds in cold climates; but has, perhaps, never been found in the torrid zone. Hence the opinion entertained by some that mosses by length of time, and by being exposed to considerable pressure, are converted into pit-coal, has at least some little plausibility in its favour. That peat is entirely of vegetable origin cannot be doubted; that it consists chiefly of *sphagnum palustre*, or *common bog-moss*, and other similar plants which delight in moisture, is probable, and that it is formed by the action of water on dead vegetable matter, appears abundantly evident. But an accurate explanation of the suite of changes which take place during the formation of peat has not been given. A precise chemical examination of peat, and a comparison of its different varieties with those of pit-coal, would be a valuable addition to geological knowledge*. In the mean time it cannot be doubted that

* Dr. Thomson asserts, that he has made some experiments on the subject, but never could find any of the constituents of peat, mentioned by Dr. Rennie in his work on peat, in any of the varieties of that combustible which he was able to procure. He has examined peat from Lancashire, from Perthshire, from the neighbourhood of Stirling, from the neighbourhood of Edinburgh, and from a moss between Stirling and Glasgow. Dry peat is tasteless and insoluble in water. But if you steep it in water for several months it tinges the liquid reddish brown, similar to moss water. In water thus tinged he never could detect any thing by reagents, except some slight traces of vegetable extractive.

mosses act a very important part in nature, and that they afford us the means of detecting many curious changes which have taken place in process of time on the surface of the earth.

Mosses always occur on plains, though these are frequently situated at some considerable height on the side of a mountain. They are always in the neighbourhood of ground higher than themselves, and are obviously the receptacle of water collected from neighbouring acclivities. They frequently contain many large trees, chiefly oak and fir, and this even in countries where trees will no longer grow, as the Orkneys and Western Islands of Scotland*. There is in an early number of the Philosophical Transactions a very valuable paper on the origin of mosses, by the Earl of Cromartie. And this nobleman, who was about the age of eighty when he wrote, had the singular good fortune to witness with his own eyes all the different steps of the process within a period of rather less than fifty years.

[*Thomson's Hist. of Royal Society.*]

Mosses, in consequence of their low position, are frequently overflowed by torrents from adjoining hills and higher grounds; and when the soil below has been spongy and cavernous, particular parts of them have often been found to tremble and move about like a boat on the water, and not unfrequently the whole range of moor or moss has sunk abruptly to a very considerable depth below its former level; and hence, in many instances, the origin of extensive lakes. Thus in Finland, no later than 1793, a piece of ground approaching to this description, of four thousand square ells, sunk to a depth of fifteen fathoms†: and in like manner a swampy seat in Norway, called Borga, in 1702, was transformed into a lake of not less than a hundred fathoms deep. The Philosophical Transactions abound with similar instances, of which it may be sufficient to notice the following: an extraordinary subsidence of a part of the cliffs or high grounds near

* The reason why wood does not grow in these places is not any change of the climate for the worse, but an increase of the number of sheep and cattle, which prevent trees from propagating themselves by seeds, the only way in which forests can be continued in a cold climate. Young trees brought from a distance and planted are sure to die.

† Götting. Taschencalendar, 1795.

Folkstone in Kent, in or about the year 1716 *, probably from subterraneous springs and caverns; a sublapse of the soil at Horseford in Norfolk, in June in 1745, during a violent thunder storm †; and the sinking of Pilling Moss in the neighbourhood of Churchtown in Lancashire, in the beginning of the same year. This moss, which was of the moving kind, had been observed a short time before to rise to a surprising height; this ascending progress however continued but for a very short period, for it soon sunk as much below its proper level, and moved slowly towards its south side, to an extent of twenty acres of land, while the country around was overflowed to a range of nearly a hundred acres with moss and water. Many families were severe sufferers by this calamity, being driven from their houses, one or two of which were overturned. The sunk part resembled the bed of a river, and ran from north to south, in length about a mile, and near half a mile in breadth. One man was walking over it when it began to quake; and was going eastward when he first perceived to his astonishment that the ground under his feet moved southward. He turned back speedily, and had the good fortune to avoid being swallowed up ‡.

From the vegetable matter contained in mosses many of them possess a peculiarly preservative, or tanning, power, in consequence of which animal substances have been occasionally found in an uncorrupted state of considerable antiquity. A few singular instances of this kind we shall notice presently. There are several mines that seem to possess a similar power but from a different cause, as the solution of sulphat of iron, or of some other vitriolic material, in the water of the mine. One of the most curious instances of this kind occurs in the *Swedish Acta Literaria* for 1722, and is given by M. Adam Leyel, assessor of metals to the Royal College, who states, that in December 1719 there was found in one of the copper mines at Fahlun, in an uncorrupted state, and converted into a horny consistence, the body of a man, who had been killed by the falling-in of a part of the mine, in the autumn of 1670, i. e. upwards of forty-

* See Mr. Sachette's account, Phil. Trans. 1716, and compare with Mr. Lyon's, id. 1786.

† Mr. Arderon's paper, Phil. Trans. 1745.

‡ Mr. Richmond's paper, id. 1745.

nine years before. Both his legs, with his right arm and head, were fractured; but his face and the rest of his body were unhurt. His flesh and skin felt rough and hard; they were not, however, in a petrified state, but only of the hardness of horn or hoof, for they could be cut with a knife.

When the body was exposed to view it was recognised (for the features still remained perfect) not only by several of the miners, but also by an old woman to whom the unfortunate man had been married, to be the body of Matthew Israel, called, on account of his height, Big or Tall Matthew, who, it was well remembered, had gone down into the mine at the date beforementioned, and had been missing ever since.

[*Editor.*]

SECTION II.

On the Mosses in Scotland. By George, Earl of Cromartie, &c.

THERE are many grounds in Scotland called mosses, where the country people dig turf and peats. The surface is covered with a heathy scurf, under which there is a black, moist, spongy earth, from three or four to seven or eight feet deep; and in some few places twice or thrice that depth. They cut the heathy scurf with a flat kind of spade, which they force horizontally between the scurf and the spongy earth, and so turn up the scurf in flat thin flakes, which they call turf. This turf, overrun with the small roots of heath, when dried, makes a wholesome brisk fire, but with much ashes, of a whitish, duskish, or reddish colour; always the whiter as it contains more of the woody roots.

The black spongy earth, which is under the turf, they cut out in oblong squares, with iron spades made of that shape, about eight or nine inches long, and about four or five inches broad; and as the men cut them up, the weaker men, women, and children, carry them in small wheel-barrows, scattering them on some dry ground, to be dried by the wind and sun: some become harder, some softer, according to the nature of the mould, or earth; the more solid, the better fire; and those are less esteemed which are more spongy. And when they have cut off one stratum of four or five inches deep, they proceed downward to another, till at last they come to the

hard channel, unless they be stopped by water; which also they usually drain off, by making a trench to some descent, if they can, and if they cannot, there the water stagnates.

And such wasted pits, where water hinders them from cutting the spongy earth to the bottom, will in a good number of years be filled up again with new ground of spongy earth; which in progress of time will come to the consistence of peat moss, as at first, and a scurfy heath turf will at last grow on the top of it.

I have observed, that peat pits, which have been dug since I remember, have grown up again with new peats; and that sometimes oftener than once in the same pits, some mosses growing in shorter time than others. But I have observed also, that when they dig the peats to the channel, or bottom, and in places where the water runs off, and does not stagnate, that the mosses did not grow, nor renew there again. Which induced me to order my tenants, not to cut the mosses to the channel, nor in very large openings, but rather in smaller pits, that they may grow again more hastily: and the event has answered my design. But within these few days, Sir Robert Adaire told me, that without cutting the mosses in the method of pits, but by cutting in fully to the channel, and by laying the heathy turf, which is cut off the top of the moss, on the channel, so as to cover it over, that in progress of time a moss would grow there again, but not so readily as in the pits.

I never observed any of these mosses, which did not lie on plains, though the heathy or heathry turf over-spreads the faces and declivities of the mountains, for the most part; there are many mosses, which lie very high on these hills; sometimes not far from the top. But the peat mosses are always in a plain, though there be descents to them, and ascents from them; yet I never observed them to stand on such a plain as the water might stagnate on: and they always have a descent to them, from some higher grounds, by which water descended to that plain; which I take to be the parent of peat.

In many of these mosses, there are found quantities of fir and oak wood; but I never observed nor heard of other kinds in them. They are usually found in whole trees; but the smaller branches are seldom found unconsumed. I have seen many, and very great trees of both kinds: generally the oak is black; the fir sometimes whiter, sometimes redder, as is observed in all firs; but neither fir

nor oak are found with any bark on them. The fir is generally as fresh and tough, and as fit for any use, as any other old timber: only they have imbibed so much water, that they take a long time to dry, and be fit for use, especially the oak; so that when put into any small work, it readily warps, and changes its figure. We never find any of the oaks standing in the woods, have that blackness; so that I presume that colour arises from the water.

There are many places, where woods do not now grow; and yet the mosses in these places are well stored with this kind of underground timber, more especially the fir; such are the Orkneys, and the Lewes isles, Caithness, Tabartness, and the coast of Buchan. So that probably there have been woods formerly in these places: and this is further confirmed by the following account.

In the year 1651, I being then about nineteen years old, and occasionally in the parish of Lochbrun, passing from a place called Achadiscald, to Gonnazd, I went by a very high hill, which rose in a constant acclivity from the sea; only in less than half a mile up from the sea, there is a plain about half a mile round, and from thence the hill rises in a constant steepness for more than a mile in ascent. This little plain was at that time all covered over with a firm standing wood; which was so very old, that not only the trees had no green leaves, but the bark was quite thrown off; which the old countrymen, who were with me, said was the universal manner in which fir woods terminated; and that in twenty or thirty years after, the trees would commonly cast themselves up from the roots, and so lie in heaps, till the people would cut and carry them away. They likewise showed me, that the outside of these standing white trees, and for an inch deep, was dead white wood; but what was within that, was good solid timber, even to the very pith, and as full of rozin as it could stand in the wood.

About fifteen years after I had occasion to come the same way, and calling to mind the old woods which I had seen, observed there was not so much as a tree, or appearance of the root of any; but instead of them, the whole bounds, where the wood had stood, was all over a flat green ground, covered with a plain green moss. I asked the people what became of the wood, and who carried it away? They told me, nobody was at the pains to carry it away; but that it being all overturned from the roots by winds, the trees lay

so thick and swerving over one another, that the green moss or fog had overgrown the whole timber; which they said was occasioned by the moisture that came down from the high hill above it, and stagnated on that plain; and they said none could pass over it, because the scurf of the *fog* would not support them. I would needs try it; and accordingly I fell into the arm-pits, but was immediately pulled up by them. Before the year 1699, that whole piece of ground was turned into a common moss; where the country people are digging turf and peats, and still continue so to do. The peats were not of the best, being soft and spongy, but become better and better, and I am informed it now affords good peats. This matter of fact shows both the generation of mosses, and whence it is that many of them are furnished with such timber.

These highland woods are usually stored with other kinds of timber; as birch, alder, ash, besides shrubs and thorns; yet we never find any of these woods remaining in the mosses. What the reason may be, that the fir and oak do not grow in several countries, where they are found so plentifully in the mosses, is matter of enquiry. It seems remarkable, that in a moss near the town of Elgin in Murray, though there is no river nor water that runs into the moss, yet three or four feet in the moss, there is a sort of small shell fish, resembling oysters, found numerously in the very body of the peats, and the fish alive within them; though no such fish is found in any water near the moss, nor in any adjacent river; nor even in the stagnating pits, that are in that moss; but only in the very substance of the turf. [*Phil. Trans.* 1711.]

SECTION III.

On the Bogs of Ireland. By Sir Hans Sloane, Sec. R. S.

WHAT the earl of Cromartie observes of the bogs or mosses in Scotland, and the wood found in them, I can confirm, having seen many such in the north of Ireland; where, when the turf-diggers have come to the bottom, or firm ground, by having dug out all the earth proper to make turf or peat, and come to the clay or other soil, by draining off the water, then there have appeared roots of fir trees, with their stumps standing a foot or two straight upright, and their branches spread out on every side horizontally on that firm

surface; as if that had been formerly the outward face of the ground, and place of their growth. And I remember to have observed these roots to be sometimes so near one another, as that their branches were, as it were, matted, grew over, and gave place to one another, as we every day see in roots of trees where they grow too close. I saw once the body of a fir-tree dug up so large, as to be judged fit for the main post of a windmill; which was discovered, as many of them are, which are not found in digging turf, by the grass, which grew over it, being, in a very dry summer, of a yellowish colour.

The Rev. Mr. de la Pryme sent me some of the cones found with this timber in the great fens of Lincolnshire, which differed in nothing from those of the Scotch fir, which is so plentifully growing in Scotland at this day, and which some years since were judged so proper by some to afford masts for the Royal Navy, that I think some persons were sent thither for that purpose. But they were not able to bring about what they intended, from the difficulties in the roads by which they were to be conveyed to the sea; which, in Norway, I have heard is in a great measure effected by the rivers. Cæsar indeed, in his Commentaries says, that the sorts of timber in this island, are the same as in France, *præter fagum et abietem*, "except beech and fir." But Lord Cromartie's account is a sufficient witness of his mistake as to one sort of these trees, and the beeches in the chiltern countries near London, prove the same as to the other. For the uses of this under-ground timber, besides those of other wood, it is split into pieces, and being lighted, supplies the use of candles. It is also made into ropes; as may be seen in the Musæum of the Royal Society, by a long piece of such rope, bought in Newry market, in Ireland, and presented to the Royal Society; the long soaking in water having rendered the wood of those trees fit to be made into ropes. This seems to prove, that as the soaking of hemp, flax, aloe leaves, &c. in water, dissolves the pulpy part, and leaves the fibrous fit for making into threads and ropes, so the long soaking of trees may, in length of time, effect the same, or a similar change in those of wood and timber.

There are some things remarkable which may here be noticed. One is, that I have seen what I thought had been pieces of wood, not only in clay pits, but even in quarries or stone-pits, in the blocks of stone raised out of their strata, or layers; and have been also as-

sured by Mr. Bellers, that he has seen large pieces of wood in the stone-pits in Gloucestershire; and also that in Lancashire there is a moss, or turf-bog, where the black spongy mould, made use of for peats, smells very strong of bitumen, or petroleum; of the oil of which it yields a very great quantity by distillation. And likewise, the late Sir Edward Hannes told me, that near the lord Blessington's house, at Blessington, in Ireland, there appeared a light where the horses trampled with their feet on a certain space of soft ground. On my desire he procured me some of this mould, which I have yet by me, and which agrees exactly in its dark colour, lightness, &c. with peat earth. And on examination of this by a microscope, I found the light proceeded from many small half-transparent whitish live worms, which lay in it.

The blackness of the oak in such bogs, in my opinion, arises from the vitriolic juices of the earth soaked into the oak, which being astringent is turned black by them. Ink is made of galls, an astringent excrescence of a sort of oak in Turkey, made by an insect there; and of green vitriol, which is made of the pyrites dissolved by rain water, and iron. Earth of all sorts, and even human calculi, and the ashes of vegetables, have in them particles of iron, in greater or less quantities. The pyrites is also very common. The particles of iron coming to be dissolved by this pyrites, subacid, or other salts, dissolved by water, or perhaps by water itself, and carried into these bogs, there fasten to the tree, soak into it, and turn it black. These particles in some river water, fastening to the oak timber floated in it, give the same a darkish colour; as noticed by Mr. Pepys, in his Naval Memoirs of England, p. 71, where we are told by the chief ship-builders of England, that the best foreign plank for the Royal Navy, was brought either from Dantzic, Koningsberg, or Riga, of the growth of Poland and Prussia, or from Hamburgh; namely, that sort which is shipped from thence of the growth of Bohemia, distinguished by its colour, as being much blacker than the other, and rendered so, as is said, by its long soaking in the water, during its passage thither.

In the turf bogs of Ireland, fourteen feet deep, are found not only mouse-deers horns, but likewise whole skeletons of mouse-deers, wherein the bones bear the same proportion to the like bones of other deer, as the horns bear to their horns. There are also

found in them, gold chains, pieces of money, and roots of heath, several musci, or mosses, and branches of trees so soft, as to give no resistance to the turf-spade: and I was told, that in cutting turf in one, they at several feet deep cut through what the Irish call a ruskin of butter, which was a firkin or vessel, made of the barks of trees, used by the old Irish for putting up their butter. And I remember, that in digging the wet dock at Deptford, there was found at the bottom, about nine feet deep, grass eaves, hazle-nuts, and roots of trees: and there also was found a piece of money, as they called it; but on examination, it proved to be a leaden seal, to some bull of Pope Gregory IX, who continued Pope from A. D. 1227 to 1241.

From Leland's Itinerary, vol. v. p. 13, &c. written in the reign of King Henry the 8th, we may learn the common opinion in his days, of the cause of the destruction of woods, with the growing of mosses and pools; and that at that time in Wales, the sense of the natives was, that the subterraneous trees found there, had formerly grown there; as appears by the following extracts, in his own words, the language of the times.

"In these deyes in Mone, wher they digge turves, be founde greate rootes of trees that serve men for wood. For after the trees were cut doune, sogging yerth and mosse overcoverid them, and now the same yerth parid away for turves, the old mayne rootes appere. Likewise at low water, about al the shores of both shores of Aberdein and Towen Merioneth, appere like rootes of trees. I saw hard by, on the lift honde, a great fenny more, owt of wich the inhabitantes thereabout digge turfes for fier, and by the same fenne is a fair Llin cawilid Llinridde, ii miles from Stratefleure. Stratefleure is set round about with montanes, not far distant, except on the west parte, wher Diffrine Tyne is. Many hilles therabout hath bene well woddid, as evidently by old rotes apperith, but now in them is almost no woode. The causses be these; first the wood cutt doun was never copisid, and this hath beene a great cause of destruction of wood thorough Wales. Secondly, after cutting doun of wooddys, the gottys hath so bytten the young spring, that it never grew but lyke shrubbes. Thirddely, men for the nonys destroied the great woddis, that thei shuld not harborow theves.

"From Whitchirch a mile and a half of I cam by the pale of the

large parke of Blackmer, longging to the erle of Shreusbiri, wherein is a very fair place or loge. The park hath both redde dere and falow. In the park (as I hard say) be iii fairle poles, of the wich I saw by the pale the largest caullid Blakein, wherof the park is namid. It is to be supposid that thes pooles for the most part in morisch groundes, and lying sumwhat in low groundes, dreane the moist places about them, and so, having no place to issue owt, stagne there. Sum be likelyhod have begon of marle pittes. For the sandy grounde of sum partes of Shropshire, and especially of Chestreshire and Lancastreshire, wille not bere corne plentifully but it be merlyed.

"From Blakemere to Byklem, in a fosse iii miles of sand, hard by Cholmeley, first I saw the great numbre of firre trees, the wiche the inhabitantes thereby communely digge up for fier wood, but ther did I se no fyrre trees grouing. Oftentimes in diggin in this mosse or more for petes or turves, they finde the hole trees of the first, sum short and some veri long, without twike or bow, lying sumtime not a foote, sumtime iii or iiii foote depe in the ground. But how or when thes trees came doune, other be cutting or wind faulle, no manne ther can telle. The wood of them in burning savorith of resine, Morle (in Darbyshire) Mr. Leleandes place is buildid, saving the fundation of stone squarid that risith within a great moote a vi foote above the water, al of tymbre after the commune sort of building of houses of the gentilman for most of Lancastreshire. Ther is as much plesur of orchardes of great varite of frute and fair made walkes and gardines as ther is in any place of Lancastreshire. He brennith al turfes and petes for the commodite of mosses and mores at hand. For Chately mosse that with breking up of abundance of water yn hid did much hurt to landes thereabout, and rivers with wandering mosse and corrupte water is within less than a mile of Morle. And yet by Morle as in hegge rowes and grovettes is meately good plenti of wood, but good husbandes keep hit for a jewell. Syr John Holcroftes house within a mile or more of Morle stood in jeopardi with fleting of the mosse. Riding a mile and more beyond Morle, I saw on the right hond a place nere by of Mr. Adderton, and so a ii miles of to Lidiate Mosse, in the right side wherof my gide said that ther were rootes of fyrre wood.

"Al Aundernesse for the most parte in time past hath beene ful of wood, and many of the moores replenishid with hy fyrre trees.

[*Phil. Trans.* 1711.]

SECTION IV.

Peat Mosses of Kincardine and Flanders in Perthshire. By the Rev. Christopher Tait.

THE mosses of Kincardine and Flanders are situated in that extensive plain or *carse* which begins at Borrowstounness, on the south side of the Frith of Forth, and a little above Eastern Kincardine, on the north side. It stretches along both sides, first of the Frith, and afterwards of the river Forth, as far as Cardross, about twenty-two miles west of the point where it begins. The breadth of this plain, or carse, at Falkirk, where it is widest, is about seven miles, including what is occupied by the Frith. At Stirling it is contracted to three-quarters of a mile, and the mean breadth of it from that place to Cardross, is about three miles. The soil is a rich blue clay, beyond any depth that has been examined, excepting that a bed of gravel rises near to the surface for the space of a mile, betwixt Blair Drummond and Ochtertyre, and dips towards the Forth, at the rate of about one foot in the hundred. Almost the whole of this tract appears to the eye like a dead flat, the only eminences in it being those of Airth, Dunmore, Craigforth, and the hill of Dript, which are all inconsiderable, both as to extent and height. These eminences also contain the only rocks discovered in the extent above mentioned, except that the Dript rock is continued across the river, and that another rock also crosses it, at what are called the cruives of Craigforth, and gives a considerable obstruction to the stream, so as to prevent the tide from flowing up farther. Throughout the rest of the carse, no stones whatever are found in the soil; but beds of sea-shells, particularly oyster-shells, appear in many places of it, as in ditches, where the earth has been dug to a certain depth, and in the banks of the Forth and its branches. A bed of this kind, of considerable thickness, is to be seen near the bridge of Goody, a small river that runs into the Forth; and another is be seen in a bank, on the south side of the road between Polmouth and Borrowstounness. When the Forth encroaches upon its banks, it also discovers large logs of timber at various depths in the clay.

Concerning the river it may be necessary to remark, that the tide flows as far as the bed of rock near Craigforth, already mentioned, which is about three hundred yards below the junction of the Teith and Forth. Above this point, the surface of the river is four feet and a half higher than the surface below, even at spring tides. The only other fall in the river from that place to Cardross, where the carse terminates, is one of three feet at the ford of Frew, about eight miles distant from the former, in a straight line.

It will serve to give some idea of the flatness of this country to observe, that by a survey taken of the river, with a view to render it navigable, it was found, that a dam four feet in height, erected at the point of Craigforth, would increase the depth of the river more than three feet as far up as the ford of Frew; and that one of five feet in height, erected at Frew, would made a like addition to the depth of the river, as far as the ford of Cardross. The height therefore of the surface of the Forth, at the ford of Cardross, above the high-water mark at the cruives of Craigforth, is less than ten feet, and this on a distance of forty miles, measuring by the course of the river, or of eighteen miles, measuring in a straight line. The surface of the river is about twenty-one feet below the level of the clay ground on each side of it; yet in floods the country is often overflowed to a considerable extent.

A great part of the surface of this country is covered by peat bogs or mosses, as they are usually called. The first of these mosses, and the farthest east, is that of Kincardine, which lies in the angle between the Forth and the Teith, and reaches westward as far as Burnbank, after which the carse is clear of moss through its whole breadth for the space of two miles and a half. Beyond this, Moss-Flanders commences, and extends westward all the way to Cardross. occupying a large portion of the carse on both sides of Forth. The moss of Kincardine, when measured twenty-five years ago, contained above 1800 acres; but the operations which will be described hereafter have now reduced it to 1500.

Both these mosses are of the same nature, as are also some others less considerable, which lie in this tract, to wit, the mosses of Frosk, Dunmore and Kinnaird, which occupy a large share of the carse that lies at the head of the Frith, and also betwixt the rivers of Forth and Carron. The moss of Frosk begins about five miles to the south-east of that of Kincardine, and the moss of Kinnaird reaches within a mile and a half of the river Carron. The length of

all these mosses, from the head of Moss-Flanders near Cardross, to the south-east point of the moss of Kinnaird, deducting the intervals that are clear of peat, is about fifteen miles, and the total of their contents is computed to exceed 9000 acres. The greatest height of the moss above the clay on which it lies is fourteen feet and a half.

The surface of the peat-moss which thus rises above the level of the carse, when viewed at a little distance, seems wholly covered with heath, but when examined more closely, is found to be made up only of small tufts of heath, intermixed with moss-plants, such as ling, cotton-grass, and in one spot with wild rosemary; these tufts being separated from each other by spaces of bog, which are quite soft, and have no plant whatever on their surface.

When laid open, this moss is found to consist of an accumulation of the *debris* of the same plants, which are more or less advanced in putrefaction, according to the depth, and the degrees of humidity and compression. At the bottom of the moss, or at the surface of the clay on which it rests, is a stratum composed chiefly of bits of rotten wood, but with which is mingled sometimes a little black earth, and sometimes also bunches of heath, far more entire than those which are found nearer to the surface of the moss. Here also are innumerable trunks of trees, lying along close by their roots, which roots are still fixed in the clay, as in their natural state. The roots of the heath are also fixed in the clay, and appear to have been the production of the soil before the moss was superinduced over it.

In the moss of Kincardine, is a considerable extent of what is called *flow-moss,* that is, flowing or fluid moss, the surface of which is smooth, and which, until lately drained, was so saturated with the water that was confined in it, either by the great extent of the moss upon all sides, or by the greater height of some of the adjoining grounds, as to be almost literally in the state which its name indicates. The other parts of the moss have generally such a degree of solidity as fits them for being cut into peat, at least towards the bottom; for in the upper parts the plants are too little advanced in putrefaction, and too little compressed, to have the cohesion requisite to be formed into peat.

The methods used for improving these mosses have been various. Sometimes, after the moss was so far drained by the common operation of making it into peat, as to bear cattle in dry weather, it

was repeatedly ploughed and burnt, so as to be converted into a manure for the clay that was under it *.

This could only be done where the moss was thin. Where it was too thick to be reclaimed in this manner, the people contented themselves with improving the surface, by ploughing the ashes into it, or by laying upon it clay brought from the adjacent cultivated grounds. The progress, however, that was made in the cultivation of the moss by these methods was never very considerable; and therefore, for some time past, they have given place to that of floating off the whole body of the moss by water, except a stratum two or three inches thick in contact with the clay. The soil thus cleared of moss is excellent, and is found to let immediately for fifteen shillings per acre. This operation of floating is rendered practicable by the peculiar nature of this moss, which, as has been said, is superinduced upon the original soil, so that the clay under it is on a level with the adjoining cultivated grounds.

This method of cultivation is supposed to have been practised on the mosses betwixt the Forth and Carron about the beginning of the present century, where it is computed, that above 600 acres have been cleared with the water collected from the moss alone, without the assistance of any stream from the higher grounds. The same method seems to have been followed in the mosses of Kincardine and Flanders about forty years ago, though with little effect, and without any general plan, till about the year 1770, when the late Lord Kames, who was proprietor of 1500 acres of the moss of Kincardine, and a considerable portion of moss Flanders, adopted and

* The people engaged in this work have their houses in the moss. These are at first sometimes built of sod, supported by a frame of wood, laid on the surface of the moss; but as soon as any progress is made in clearing the ground, they are cut out of the moss itself. For that purpose, a drain is cut through the moss, and at least a foot deep into the clay, as far as the intended house is to reach; a space from two to six yards wide is then cleared all round it; and lastly the area of the house is also cleared, leaving a wall of moss on every side, about four feet and a half thick at bottom, and three feet thick at top. The feet of the cupples which are to support the roof are inserted into this wall, but do not rest upon it, as they reach as low as the clay, from which they rise up, nearly perpendicular, as far as the top of the wall. The gables are completed with sod or mud. As the moss walls dry, and are consolidated, what was originally ten or twelve feet high, sinks down to the height of five or six feet.

greatly improved it. It is now in general use, and is conducted in the following manner.

A channel, about eighteen inches wide and two feet deep, is dug in the clay along the edge of the moss intended to be removed through which a stream of water is conducted about a foot deep. The workman, with a wooden spade, then cuts away a layer of the moss along the edge of the channel to the breadth of about six feet, and throws it into the water, which, if the channel has a tolerable declivity, will serve to carry away as much moss as six men can throw into it. The moss being thus removed for the whole length of the channel, to the depth of about thirteen inches, and to the distance of about six feet, the operation is repeated upon the moss below, and so on, till there is left a stratum of moss, only six inches thick, upon the surface of the clay. This thin stratum of moss, being dried by the summer heat, is afterwards dug, or ploughed, and burned, and when the ashes thus produced are ploughed into the clay, the ground is thought sufficiently prepared for a crop of oats.

At the bottom of the moss when thus cleared, a multitude of the bodies and roots of trees are found, which leave no doubt, that the grounds thus covered by the moss have been once occupied by a forest. Though it is not, I believe, unusual to meet with trees in mosses, yet they are rarely found in such abundance as in the present instance. For they are found here lying as thick upon the clay as they can be supposed to have grown upon it; and what is yet more singular, the roots remain fixed in the clay in their natural state, corresponding in size and in species to the trees that lie by their sides.

The trees are oak, birch, hazel, alder, willow, and in one place there are a few firs. Among these the oak abounds most, especially upon the west side of the moss, where forty large trees of this species were lately found lying by their roots, and as close to one another as they can be supposed to have grown. One of these oaks measures fifty feet in length, and more than three feet in diameter, and three hundred and fourteen circles, or year's growths, were counted in one of the roots. In another part of the moss, an oak was found that measured four feet in diameter; and I am assured, that some years ago a root was discovered at Ross, on the south side of the moss, that was fifteen feet in diameter at the surface of

of the clay; and the tree, which was twenty-two feet in length, was four feet eight inches in diameter at the lower end, where it had been cut over, at the height of a yard from the ground.

The oak is usually black, and the wood still sound, especially on the side of the tree that lies next the clay. It is fit for various purposes, and would probably be of much greater value, if the people into whose hands it falls had skill to dry it properly. As it is managed, it usually opens into various fissures, which disqualify it for being sawn into planks.

The roots of the oak are all found fixed in the clay in their natural state, and usually rise above it to the height of about three feet. They are very little rotten, and it requires much labour to grub them up.

The other kinds of trees are so much decayed, that fewer observations can be made upon them. Their roots are also fixed in the clay; but they generally rise not more than a foot and a half above its surface.

The facts which have now been described will perhaps be found, upon examination, to point out the cause by which these trees were brought into their present situation, and also the time when that event must have taken place.

For, first, these facts are utterly inconsistent with the supposition, that the trees have fallen through natural decay; as in that case, they must have been broken over at different heights above the surface, and both the trunks and the roots must have been too far advanced in putrefaction, before the moss was formed over them, for any part of them to remain sound at this day.

The same circumstances seem also irreconcileable with the supposition, that these forests have been blown down by the wind, as in that case also the trees must have been broken over at different heights, and must frequently have been torn up by the roots; a single instance of either of which has not been seen by the author of these remarks. It is indeed said, that a few single roots, in different parts of the moss, have been observed, which seem to be torn up, and what is perhaps difficult to be explained, no trunk was found attached to them.

It cannot be admitted as an argument in support of the preceding supposition, that the trees lie most frequently in the direction from south-west to north-east. For as the south-west wind is the pre-

vailing and most violent wind in this country, the weight of the tops of the trees is generally turned from that quarter; and by whatever cause they fall, they will therefore, in general, be directed towards the north-east.

The most plausible solution therefore is, that ths trees have been cut down. The height of the stumps which is commonly about two feet and a half, favours this opinion, as, at that height, the diameter of a large tree is usually much less than it is nearer the ground, and as the cutter can better apply his strength at this than at a greater height. The soundness of the roots and trunks seem also inexplicable on any other supposition.

Marks of an ax, not exceeding two inches and a half in breadth, are sometimes discernible on the lower ends of these trees. The small breadth of the ax, and the length of the time that the trees doubtless remained exposed before they were covered with the moss, seems sufficiently to account for these marks not having been more frequently discovered.

But it will be asked, what reason can be assigned for undertaking a work of so great labour as the cutting down of such extensive forest must have been? The value of the timber was evidently not the motive of this work, otherwise the trees would not have been left behind. Neither was the clearing of the ground the object that was in view, since, after all this labour, the ground remained as much incumbered as before. If, however, we recollect the history of Britain from the reign of Domitian to the accession of Caracalla, and consider the local situation of the mosses, we will find good reasons for ascribing the destruction of the forests in question to the Romans.

It is well known, that from the time when Julius Cæsar first invaded this island to the decline of the Roman power, the Britons, unable to contend with the arms and discipline of the legions in pitched battles, or in the open country, were forced to take shelter in their woods and morasses, from which they annoyed the Romans by their incursions. The Roman generals, therefore, from the time of Agricola at least employed not only their own soldiers, but also many of the provinciated Britons, in depriving the free Britons of their places of refuge, by cutting down the woods, or, at least, making great openings in them, and by draining the morasses, or making roads through them. These seem to be the servile labours which

Galgacus, in his speech before the battle with Agricola, warns the Caledonians of, as awaiting the vanquished. "Corpora ipsa ac manus, sylvis ac paludibus emuniendis, inter verbera ac contumelias conterunt *."

In like manner, Severus is said to have employed a great part of his troops, not only in building the wall which bears his name, but in cutting down the woods, draining the marshes, and throwing bridges over the rivers which obstructed his march into the northern parts of Britain †. But though in that march he must probably have passed over the very grounds now occupied by the mosses of Kincardine and Frosk, I am inclined to believe, that the destruction of the forests, upon the side of the Forth, is rather to be attributed to his predecessors, who aimed at making the wall between the Friths of Forth and Clyde, the limits of their empire, than to Severus himself, who withdrew his troops from the country betwixt the two walls, and either strengthened Adrian's wall, from the Tyne to the Solway Frith, or built another nearly in the same direction.

The Romans indeed must have found themselves more incommoded by the forests in question than by any other almost in the island; both because of their vicinity to the Roman province, and because the only roads by which the Romans could penetrate into the country possessed by the Caledonians were through the Carse, and across the grounds between the mosses of Frosk and Kincardine.

The moss of Kinnaird, which was no doubt formerly united to that of Frosk, is only a mile and a half distant from the river of Carron, which river, where it enters the carses and ceases to be fordable, seems to have been the boundary of the Roman province ‡, and the moss of Kincardine is only twelve miles distant from the station at Camelon. Forests, therefore, in either of these places would have afforded very convenient refuge to the Caledonians,

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* Tacitus in Vit. Agric. cap. 31.

† Σεβῆρος διϊὼν της Καληδονίαν, ἀμύθητα πράγματα εχε, τας τε ὕλας τεμνων, τα τε ἕλα χωννυων, και τους ποταμους ζευγνύων. Dio. Cass. lib. lxxvi. cap. 13. The works here enumerated were attended with such difficulty, that though, according to the same historian, Severus was never met by the British army in the field, he lost fifty thousand men in the course of this expedition. Ibid.

‡ That the river Carron was the boundary of the Roman province is rendered probable by the situation of Arthur's Oven, as it was called, which is supposed to have beea temple dedicated to Terminus, and erected near the

whether they were making incursions into the Roman province, or harassing the Roman armies in their expeditions towards the north.

Besides, that a people, more civilived than the ancient Caledonians, must have been in this country before the moss of Kincardine existed, is completely established by the discovery of a road on the surface of the clay at the bottom of that moss, after the peat, to the depth of eight feet, had been removed. The part of this road already discovered is about seventy yards long; the breadth of it is four yards, and it is constructed of trees, measuring from nine to twelve inches in diameter, laid in the direction of the road. Across these have been laid other trees about half their size, and the whole has been covered with brushwood. The depth of the materials varies in conformity to the nature of the soil; the trees, which are laid lengthwise, being generally on the surface of the clay, but in the lowest and wettest parts, they are sunk about two feet under the surface.

This road lies across a piece of ground lower than the adjacent grounds, and its direction is from the Forth across the moss, where it is narrowest, towards a road, supposed to be Roman, that passes between the moss and the river Teith. The vestiges of this last road have been traced, from about four miles north-west of the bridge of Dript, where formerly there was a ford, across the river, south-east by Torwood and Larbert, to Camelon on the wall. This road is laid about a foot deep with gravel, under which, in some places, is also a layer of stones, and it appears to have been about twenty feet wide, though, by the land having been under tillage, its breadth cannot be exactly ascertained. The direction of it, after it crosses the Forth at Dript, is in a line that points north-west to the pass of Leny, the chief avenue to the Highlands on this side, and through which the military road to Fort William is now actually conducted. It is therefore considered, with great probability, as having been originally designed for the use of the troops employed to repel the incursions made by the Caledonians, from the mountains, into the

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Roman frontier. It stood on the west side of the river Carron, or between that river and Kinnaird. There is also a passage in Herodian that favours the same opinion. That historian mentions the army of Severus passing τα προβεβλημενα ῥεύματά τε και χώματα της Ρωμαιων αρχης. He adds, that on this frontier the Barbarians easily made their escape, *and concealed themselves in the thickets and marshes.* Herod. lib. iii. cap. 48.

Roman province. At the same time, it may have been connected with the other roads that stretched more directly toward the north, by Dumblane and the well-known station of Ardoch. It can scarcely be doubted, that it also communicated with the road in the moss, and that this last is to be reckoned a part of the military works of the Romans.

On the whole, therefore, the conclusions to which we are thus necessarily led appear to be these: that before the time of Agricola, the first of the Roman generals who attempted to secure the northern frontier of the province by a regular chain of posts *, the greater part of the level country on the banks of the Forth was occupied by extensive forests; that about this period, or soon afterwards, a great part of these forests, being at no great distance from the above frontier, were cut down by the Romans for the purpose of depriving the natives of the fastnesses and places of strength from which they were continually making incursions into the province; and that from the trees thus cut down, and suffered to rot upon those low and marshy grounds, originated the vast body of peat-moss which covers them at the present time. The production of peat-moss from the decay of forests, is not a *postulatum* that will be supposed subject to any difficulty. It is a principle admitted by naturalists, on the ground of actual observation †, with respect at least to countries in high latitudes, and serves to explain many appearances in other parts of this island, which have a great resemblance to those that have now been described ‡.

[*Trans. Royal Soc. Edin. Vol.* III.]

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* The chain of posts between the Forth and Clyde is mentioned by Tacitus, Vit. Agric. cap. 23, as the work of Agricola's fourth campaign, which coincides with the year 81 of our æra. See Horseley's Britan, book i. chap. 3. It was about fifty years afterwards that the wall of Antoninus was built, nearly in the same line. The age of the moss cannot therefore be estimated at much less than 1700 years.

† See Lord Cromarty's paper on Peat-moss, chap. xxvi. sect. ii.

‡ See an account of Hatfield Chace near Doncaster, Phil. Trans. vol. xxii. p. 980. It may be proper to observe, that the mosses of Kincardine, &c. being placed above the level of the adjacent plain, are of the kind that might be expected to break out and overspread the lower grounds, which however they are not known to have done, while they remained in their natural state. They do not indeed abound very much in water, insomuch that the floating off of the peat, when it is carried to such an extent as it is now, requires an artificial supply of water. This supply is accordingly procured at present by an engine

SECTION V.

Irruption of Solway Moss. By Mr. J. Walker, of Moffat.

It is not surprizing that this irruption has every where attracted the attention of the public; for though the cause of it is obvious, yet the alteration that it has produced on the face of the earth, seems to be greater than any we have known in Britain, from natural causes, since the destruction of Earl Goodwin's estate. It happened on the 16th of December, when there fell such a deluge of rain, over all the north of England, as has not been known for at least 200 years. There was a very great flood at Moffat, but Mr. W. thinks he has seen one or two greater, and certainly it was not so extraordinary here as farther south.

The Solway flow contains 1300 acres of very deep and tender moss, which before this accident were impassable, even in summer, to a foot passenger. It was mostly of the quag kind, which is a sort of moss covered at top with a turf of heath and coarse aquatic grasses; but so soft and watry below, that if a pole is once thrust through the turf, it can easily be pushed, though perhaps 15 or 20 feet long, to the bottom. If a person ventures on one of these quags, it bends in waves under his feet; and if the surface breaks,

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which Mr. Drummond has caused to be erected for raising the water from Teith, and which is one of the most material improvements that has been made in the husbandry of the moss.

But though there is no memory of the moss having flowed while it remained in its natural state, on the 21st March 1792, it burst out on the west side, near the southermost cottage, to the height of its side wall, covering fifty-six yards in breadth, and about the extent of an acre of ground that had been cleared, and early in the morning of the same day of 1793, it was discovered to have flowed again, and to have reached the northermost cottage of the same line of houses. The inhabitants escaped by a window on the opposite side of the house. The moss afterwards bore down the side walls of the house that were built of stone, and continued to flow slowly forward, eight feet in depth at the middle, and 1200 feet in breadth, until nine o'clock in the morning of the 23d, when it had advanced 600 feet, and covered twelve acres of ground that had been cleared. It would undoubtedly have flowed much farther, had not a great number of men been employed night and day, in giving vent to the water mixed with the moss that had flowed, and in intercepting that which continued to discharge itself from the main body of moss.

he is in danger of sinking to the bottom*. The surface of the flow was, at different places, between 50 and 80 feet higher than the fine fertile plain, between it and the river Esk. About the middle of the flow were the deepest quags, and there the moss was elevated higher above the plain, than in any part of the neighbourhood. From this, to the farm called the Gap, upon the plain there was a broad gully, though not very deep, through which a brook used to run. The moss, being quite overcharged with the flood, burst at these quags, about 11 o'clock at night, and finding a descent at hand, poured its contents through the gully into the plain. It surprized the inhabitants of 12 hamlets in their beds †. Nobody was lost, but many of the people saved their lives with great difficulty. Next morning, 35 families were found dispossessed, with the loss of most of their corn and some cattle ‡. Some of the houses were near totally covered, and others of them he saw standing in the moss, up to the thatch, the side walls being about 8 feet high.

In the morning, above 200 acres were entirely overwhelmed; and this body of moss and water, which was of such a consistency, as to move freely, continued to spread itself on all hands for several days. It was come to a stop when Mr. W. saw it, and had covered 303 acres, as he was informed by a gentleman, who had looked over the plans of the grounds, with Mr. Graham the proprietor: but every fall of rain sets it again in motion, and it has now overspread above 400 acres. At the farthest part it had run within a musket shot of the post road leading from Moffat to Carlisle, when he saw

* The surface was always so much of a quagmire, that in most places it was hardly safe for any thing heavier than a sportsman to venture on it, even in the driest summers. A great number of Scotchmen, in the army commanded by Oliver Sinclair, in the time of Henry 8th, lost their lives in it; and it is said that some people digging peats on it, met with the skeleton of a trooper and his horse in complete armour, not many years ago.—Orig.

† Those who were nearest the place of bursting, were alarmed with the unusual noise it made; others not till it had entered their houses, or even, as was the case with some, not till they found it in their beds.—Orig.

‡ The case of a cow seems singular enough to deserve a particular mention. She was the only one of 8 in the same cow-house that was saved, after having stood 60 hours up to the neck in mud and water. When she was got out, she did not refuse to eat, but water she would not taste, nor could even look at, without showing manifest signs of horror. She is now reconciled to it, and likely to recover.—Orig.

it, but it is since overflowed the road, and reached the Esk. This river, which was one of the clearest in the world, is now rendered black as ink, by the mixture of the moss, and no salmon has since entered into it. A farmer also told him, that on removing the moss, to get at a well which it had covered, they found all the earth-worms lying dead on the surface of the ground. The land that is covered was all inclosed with hedges, bore excellent crops of wheat and turnips, and rented from 11 to 14 shillings, besides the taxes and tithes, which amounted to 4 shillings per acre.

Mr. W. endeavoured to guess at the depth of the moss on the plain, by a large thorn, which stands in the middle of it, and which is buried to above the division of the branches. The farmers told him, that it stood upon a rising, more than 6 feet above the general level of the plain: and that it was upwards of 9 feet high, of clear stem. By this account, great part of the plain must be covered 15 feet deep with the moss: and near the farm called Gap, there were some considerable hollows, where they think the moss, at present, lies full 30 feet deep. The tallest hedges on the land are all covered over the top. The houses are not so much buried, because they stood mostly on the higher parts of the fields; and towards the extremities of the moss, he observed it, in many places, not above 3 or 4 feet deep, owing likewise to the rising of the ground.

The gut through which the whole of the moss flowed that covered the plain, is only about 50 yards wide, and the gully near a quarter of a measured mile long. The brook being stopped up by the moss, has now formed a lake.

About 400 acres of the flow, next the place of its evacuation, appear to have sunk from 5 to 25 feet; and this subsidence has occasioned great fissures on those parts of the moss which refused to sink. These fissures are from 4 to 8 feet wide, and as much in depth. The surface of the flow, consisting of heath and coarse grass, was torn away in large pieces, which still lie on the surface of the new moss, some of them from 20 to 50 feet long. But the greater part of the surface of the flow remained, and only subsided; the moss, rendered thin by the flood, running away from under it.

Looking over the Solway moss, at the village of Longtown, where there is a bridge on the Esk, they formerly saw only the tops of the trees at Gratney, a house of the Marquis of Annandale's, 4

miles distant; but now they see them almost to the ground. And looking over it, in another direction, they now see two farm-towns of Sir William Maxwel's, which were not before visible. So that the ridge of the flow or moss seems to have subsided about 25 feet. [*Phil. Trans.* 1773.]

SECTION VI.

Tanning, or Preservative Power of Mosses.

THE beginning of June last, (1747,) a labouring man, of Amcotts in the isle of Axholm, in the county of Lincoln, was digging turf or peat in the moors of Amcotts; and, about 6 feet below the surface, his spade cut the toe of a sandal, which dropped into the pit he was graveing peat in; also part of the foot dropped in, which terrified the man, and he left it. Hearing of this discovery, Mr. S. went with some servants to make further discovery; when they soon found the other sandal, whole and firm. It was very soft and pliable, and of a tawny colour, with all the bones of that foot in it. and all the gristly part of the heel. Proceeding further, they found the skin and thigh bones, which he measured, and found to be 18 inches long. They then found all the skin of the lower parts of the body, which was of the same colour as the sandals, and very soft, with fresh hair on it, &c. which distinguished it to be a woman. The skin drew or stretched like a piece of doe leather, and was as strong. They then found the skin of the arms, which was like the top of a muff or glove, when the bones were shaken out. They then found a hand, with the nails as fresh as any person's living; this hand is the lady's natural skin so tanned, with the nails.

These sandals must be very ancient, and have most certainly been made of a raw hide, as they and the skin of the lady were both of one colour, and both had one tanner; which probably is the moor water; which is exactly of the colour of coffee; and made so by such great quantities of oak and fir-wood, that are frequently dug out of these moors; several oak-trees affording 1000 pales for fencing, 5½ feet long, and 6 to 8 inches broad, which oak-wood is as black as jet. The fir-wood retains its turpentine smell, and in hot weather, exposed to the sun, the turpentine will drop from it. This wood is frequently split into laths for the roofs of houses or floors; and it is remarkable that no worm will touch them. They frequently find also hazle-nuts and fir-apples in abundance; which

is a plain proof that the trees fell in autumn, when the fruits were at maturity. This lady was probably overwhelmed by some strong eddy of water; for she lay on one side bended, with her head and feet almost together.

It appears by the maps of the country, that this has been the rendezvous of all the waters from the south, west, and north parts of the kingdom; as for instance, the river Don from Doncaster, Rotherham and Sheffield, which took in many more streams: as the Idle, Trent, Torn, Dare, Rother, &c. &c. Then the river Trent, which runs south to Gainsbrough; then to Torksey, Newark, Nottingham, Derby, Burton on Trent, Strafford, Trentham in Staffordshire; and takes in a vast number of rivulets: then the Ouse, which comes from near Richmond, and takes in the Ure, Wharf, Bishop's Dike, Aire, Calder, and a great number of rivulets; which are all lost in that famous estuary the Humber.

It is also to be observed, that here is one morass 20 miles round, part in Hatfield-chace, another 10 miles round in the same chace, where the famous William of Lindham had his cell. In the middle of it, where his body was found, for 8 miles round, is all a morass.

These sandals are not like the Scotch or Irish brogues; though the Scots formerly inhabited but a little way off, viz. north of Humber. Perhaps the Danes wear such, or the ancient Saxons; for both these people must be well acquainted with these parts, as the Danes under Edgar-Atheling, encamped a whole winter in this neighbourhood, and had a station at Gigansburgh, now Gainsbrough, on this river Trent. The sandal is of one piece of leather, with a seam at the heel, and a thong of the same leather.

At Roxby was a famous Roman pavement, 15 yards square, the Roman road, &c. also a square platform at Aldbrough, which seems to be Roman, though no discoveries have as yet been made there; but at Roxby large quantities of Roman coins have been found.

P. S. As to this water on these moors preserving human bodies *, it is most certain that part of a body was taken up at Geel by Mr. Empson 50 or 60 years ago, and one in the great moor near Thorn, about 7 years ago, with the skin like tanned leather, the hair, teeth, and nails quite fresh †.

[*Phil. Trans.* 1747.]

* See Phil. Trans. No. 434.—Orig.

† Mr. Catesby, F. R. S. author of the History of Carolina, &c. being present at reading the above account, when the sandal was exhibited, said, this shoe

CHAP. XXVII

ON PETREFACTIONS, AND OTHER EXTRANEOUS FOSSILS.

SECTION I.

Introductory Remarks.

THE close of the last section of the preceding chapter leads us naturally to the subject of the present. That the earth has sus-

or sandal was exactly like what the Indians in Virginia wear at this day, and call Mokasin.

That ingenious artist and skilful antiquary Mr. Geo. Vertue communicated to Dr. C., M. D. his sentiments concerning this sandal in the following words:

"When the above letter was read at the Society of Antiquaries, there was produced a hand of the woman there mentioned, and a sandal or shoe taken from one of her feet; it being made of leather, tanned ox-hide; but remarkable for being cut out of one flat piece, so as to fold about the foot and heel; the form and make being so contrived without under heel-piece, as to be flat to tread on; the shape, that of a woman's foot, and the toe round pointed. This being of an ancient form, the society ordered an exact draught to be taken of both that and the hand; which drawings are preserved among others belonging to that society. It may be observed concerning the antiquity and use of leather shoes in England, that this shoe or sandal appears by its form to be ancient. I conceive it was before Edward the Fourth's time, when by custom piked shoes had so increased in length, that all such as wore them in excessive length were to be mulcted, or have them cut shorter, in passing in or out of the city gates of London. This very likely had passed among the better sort of people about the kingdom; for Chaucer in his time mentions the use of long piked shoes, so long as to be tied up by strings or small chains to their knees. Thus it might have been with men's shoes, but not in so long a degree for women's use; though observing ancient pictures of men and women in books of illuminations, piked shoes appear in several reigns from Edw. 3d to Richard 3d in England."

"Also on our ancient monuments of stone or alabaster, cumbent statues have mostly piked shoes. But some of earlier date than Edw. 3d have broad turn-up shoes at the toes, of the same like form and make as this woman's. The men's broad toes, and the women's narrow.

"Therefore I conclude this very sandal could not well be earlier than Edw. 1st or Hen. 3d; also that the cutting and sowing to form the heel cleverly, by a stitching behind the heel with a small leather thong, may have been in use before that of waxed thread used by shoe-makers, formerly called cordwainers."

tained severe and extensive convulsions from a variety of causes is obvious to the attention of every geologist. We have already pointed out a few of these, as earthquakes, volcanoes, heat, moisture, and electricity. But it is probable there have also been others, and which have operated through a still wider range. The variety of fossil substances, many of them marine productions, and some almost preserving a recent appearance, that are found in mountains remote from the sea, are undeniable proofs that the levels of the earth's surface must have undergone considerable changes; although some philosophers are of opinion that such of the primary mountains as are above six or seven hundred feet high, have never been wholly covered by the sea. It is not at all easy to explain the change of climate, which some of these circumstances appear to indicate; the remains of animals inhabiting hot countries, and the marine productions of hot climates, which are frequently found in high northern latitudes, would induce us to suspect, that the position of the earth's axis was at a former time very different from its present position; and we can scarcely assign any other probable cause for this change, than the casual interference, and perhaps incorporation, of a comet with the earth. The probabilities of such an event, in the whole course of time, are however so small, that we have no reason to be apprehensive of the chance of its occurring in future, for it is not enough that a comet should approach so near to the earth as to be very powerfully attracted by it, its motion must also be directed almost in a straight line towards the earth: otherwise it might only be inflected into a new orbit, and go off again, without having caused any other disturbance than a partial overflow of the sea.

The face of the globe has also been very materially changed in the course of ages, by the gradual operation of the sea and of rivers. The sea has encroached in particular parts, and retired from others; and the mouths of large rivers, running through low countries, have often been variously modified, by a deposition and transfer of the matter washed down from the land. At Havre the sea undermines the steep coast, and recedes at Dunkirk, where the shore is flat: in Holland, the Zuyder Zee was probably formed in the middle ages by continual irruptions of the sea, where only the small lake Flevo had before existed; and the mouths of the Rhine have been considerably altered, both in their dimensions and in their directions.

The mud, deposited by large rivers, generally causes a delta, or triangular piece of land, to grow out into the sea; thus the mouth of the Mississippi is said to have advanced above fifty miles since the discovery of America; and the sea has retired from Rosetta above a mile in forty years. The mouths of the Arno and of the Rhone consist also in great measure of new land.

Hence into whatever part of the earth's surface we dig, we are almost sure to find remains of animal or vegetable materials. These substances occur in three states: sometimes they are a little altered; sometimes concreted into stone; and sometimes only the impressions of them remain, or the moulds in which they have been inclosed. The term petrefaction, strictly speaking, applies only to the second of these states; but it has been usual, for the sake of conveniency, to extend it to all three. And besides these, we are not unfrequently digging up remains of artificial utensils and implements, coins, rings, and similar ornaments, houses, whole streets, and towns, evidently proving an entensive population in situations which in the present day are found at a depth of many feet or even fathoms below the surface of the earth. Dr. Thomson has given a good summary of the former of these, and we readily present it to our readers.

1. *Vegetable petrifactions.* Wood occurs in great abundance in many parts of England, buried at various depths under the surface, and very little altered either in its texture or properties. Lincolnshire, and a considerable tract of the country on the banks of the Humber and the Thames, contain abundance of trees, at no great depth below the surface. In the isle of Axhole, lying partly in Lincoln and partly in Yorkshire, oak, fir, and other trees, are frequently found under ground in the moor. The roots are still found as they grew, in firm earth, under the moor; but the trees had been cut down. The size of many of these trees is immense; some firs have been taken up thirty-six yards long. The quantity of these trees was so great, that, during the 17th century, many cart-loads of them were taken up every year*. Oaks, and fir trees, are also dug up at Youle, about twelve miles below York; where the Dun runs into the Humber. They are at some depth, and lie in a bog, which

* Phil. Trans. 1671. vol. v. p. 2050.

is covered with sand, and the sand with soil *. The famous levels of Hatfield Chace, in Yorkshire, consisting of 180,000 acres, were, during the 17th century, drained at a vast expence, by Sir Cornelius Vermuiden, a Dutchman. Even as low as the bottom of the Ouse, and in the whole marsh, abundance of firs, oaks, birch, beech, yew, thorn, willow, ash, &c. were found †.

De la Pryme endeavours to account for the existence of so much wood all over that tract of country, by supposing, that when the Romans were employed in the conquest of Britain, the whole country was covered with forests, in which the Britons lurked, and from which they were accustomed to make frequent incursions upon the Romans. To put an end to these troublesome attacks, the Romans cut down all the woods, and left the trees as they fell. Soil and vegetable matter gradually accumulated over these trees, and preserved them from destruction ‡. This conjecture must be allowed to possess plausibility. The trees must be admitted to be destroyed on purpose, as many of them exhibit the mark of the hatchet, and many of them shew evident traces of fire; besides, various remains of Roman cutting instruments, and other utensils, are found intermixed with the prostrate trees.

About the year 1705, there was an inundation of the Thames, at Dagenham and Havering marshes, in Essex, which made an excavation nearly twenty feet deep, and laid open a great number of trees, mostly alder (as was supposed from their texture), buried under a soil, obviously composed of the mud of the Thames. Trees, in a similar situation, have been discovered all along the Essex banks of the river. Dr. Derham, to whom we owe the account of these trees, supposes, with considerable plausibility, that they had been overturned by some inundation of the Thames, and afterwards covered by the repeated overflowings of the river, which took place every tide, before its waters were confined by means of artificial banks §.

In the neighbourhood of Lough Neagh, in Ireland, very large masses of petrified wood are found, all of them siliceous, and of course exceedingly hard. The grain of the wood is still very dis-

* Dr. Richardson. Phil. Trans. 1697. vol. xix. p. 526.

† Rev. Abraham de la Pryme. Phil. Trans. 1701. vol. xxii. p. 980.

‡ Phil. Trans. 1701. vol. xxii. p. 980.

§ Phil. Trans. 1712. vol. xxvii. p. 478.

tinct; and, in some specimens, pieces of wood still unchanged may be detected. The wood is of various kinds: holly, ash, and oak, are mentioned by different writers; but it is no easy matter to determine, with accuracy, the species of wood from a petrified specimen. On the petrified wood of this lake, there are no fewer than four papers in the Philosophical Transactions *; the best of which is that of Mr. Simon. In these papers, an attempt is made to prove that Lough Neagh possesses the property of petrifying wood, when left for some time in it; and this property is even ascribed to the sand, which extends to some distance on the sides of the lough. But there is no foundation whatever for this opinion. The petrifactions are of a very old date. The waters of the lough in no respect differ from otherwaters.

Besides the petrified wood from Lough Neagh, concerning the reality of which there can be no doubt, there is an account in the Phil. Transactions of a great variety of petrified fruits, dug up in the isle of Sheppey. The account is by Dr. Parsons; and is so imperfect that it is difficult to make any thing out of it. There can be little doubt, however, that these supposed petrifactions are entirely fanciful; and nothing else than accidental imitations of the fruits in question.

2. *Shells and Zoophites.* These are by far the most abundant of all the animal remains which occur in the mineral kingdom. They occur most frequently in lime-stone rocks, though they are not entirely confined to them. They have been seen pretty often in slate clay, and bituminous shale. These substances occur in the mineral kingdom in two states: sometimes they are unaltered; sometimes they are petrified, or converted into stone. The stony matter is most commonly carbonate of lime; but very frequently also it is pure silica. This, in particular, is the case with most of the numerous petrifactions of echini, and other similar animals, which occur so abundantly in chalk. Some mineralogists go so far as to suppose, that all the flints which occur in such quantities in chalk, and in lime-stone, are petrifactions. But this has not been proved, nor even rendered probable; though it must be acknowledged, that petrifactions very frequently occur in flints. Some kinds of lime-stone are wholly made up of shells; and, in the South Seas, the coral accumulates in such quantities as to form islands of considerable size.

* Molineaux. vol. xiv. p. 552. (1684.)—Smyth. vol. xv. p. 1108. (1685.)—Simon. vol. xliv. p. 305. (1746.)—Bishop Berkeley, vol. xliv. p. 325. (1746.)

The papers in the Transactions, respecting the depositions of shells and coral, in various parts of the kingdom, are not of very great value, though the facts are worth enumerating.

Dr. Lister gives a description of *trochitæ* and *entrochi*, or *St. Cuthbert's beads*, as they are usually called in this country, which occur abundantly in the scars, at Broughton and Stock, small villages in Craven *. They consist of lime-stone, and are obviously remains of different species of the isis, especially the entrochus, which is usually found petrified. They occur also in abundance in Holy Island, upon the coast of Northumberland, where there is a bed of lime-stone, that is thickly planted with them. By the sailors on that island, they are considered as a preservative from drowning, and therefore sought after with eagerness.

Lister also gives an account of glossopetræ, or shark's teeth; which occur in considerable quantity in the Isle of Sheppey, and in a quarry near Malton †. These, indeed, ought rather to be reckoned among bones than shells; but, in mineralogical collections (probably on account of their size), they are usually put along with shells.

To the same indefatigable conchologist, we owe an account of the astroites, or star-stone; also a species of zoophyte, consisting of lime-stone; which he found deposited in beds of clay, in the Yorkshire wolds ‡.

At Reading, in Berkshire, there is a bed of oyster-shells, lying over chalk (a circumstance by no means common). This bed is two feet thick, and is covered by the following beds: 1. clay; 2. fuller's-earth; 3. sand; 4. red clay for bricks, which constitutes the bed at the surface of the earth. The oyster-shells are very brittle, and consist entirely of carbonate of lime. Probably, though Dr. Brewer, to whom we owe the account, makes no mention of the circumstance, all the animal membrane which fresh oyster-shells contain, had disappeared. This is usually the case with shells, when found in similar situations, and is the cause of their brittleness §.

At Broughton, in Lincolnshire, there are two quarries, containing abundance of fresh-water shells. These shells occur in a blue stone,

* Phil. Trans. 1673. vol. viii. p. 6181.
† Phil. Trans. 1675. vol. ix. p. 274.
‡ Phil. Trans. 1675. vol. ix. p. 274.
§ Phil. Trans. 1700. vol. xxii. p. 484.

which De la Pryme, to whom we owe the account, conceives to have been formerly in the state of clay, and to have become gradually indurated. The shells are pectinites, echini, conchites, some pieces of coral, and shells of the fresh-water muscle, probably the mya margaritifera *.

About a mile from Reculver, in Kent, there occurs a bed of shells, consisting entirely of white conchites, and very brittle. This bed is twelve feet thick, lies in a greenish sand, and contains here and there in it pieces of wood †.

The cliff at Harwich, at the side of the entrance of the river is about fifty feet high, and consists of sand. In this sand are found a great variety of shells. Mr. Dale has given us a catalogue of them, to the number of twenty-eight. The following are the names of genera which he found, according to the method of Lister, at that time generally followed: ten species of buccina, two of cochleæ, one nerita, one turbo, one pecten, one auricularia, seven pectunculi, four conchæ, one trigonella ‡.

On digging a moorish pasture, in Northamptonshire, abundance of snail and river shells were found. The digging was not continued farther than three feet; but the proportion of shells always increased the lower down they got. The experiment was tried over a considerable extent of ground, with the same effect. The shells found, distinguished by their Listerian names, were, buccinum exiguum, cochlea umbilicata, cochlea citrini, and common striped snail shell. The river shells were, periwinkle of three wreaths, and a periwinkle of five. Fresh shells, of the same species, are still found in the neighbouring peat soil §. The preceding account is by no means satisfactory; it is probable, that the place examined had been, at some preceding period, overflowed with water, and the shells left mixed with the mud and sand, after the retreat of the water.

There is a species of petrifaction distinguished by the name of

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* Phil. Trans. 1700. vol. xxii. p. 677. The names of the shells, given in the text, are Lister's. It is not easy to accompany these names with the Linnæan synonymes; as De Pryme enumerates only genera; and does not venture to give specific names.

† Stephen Gray. Phil. Trans. 1701. vol. xxii. p. 762.

‡ Phil. Trans. 1704. vol. xxiv. p. 1568.

§ Morton. Phil. Trans. 1706. vol. xxviii. p. 2210.

belemnites; usually cylindrical, or conical; sometimes containing a hollow nucleus, divided into compartments; sometimes not. They are often of considerable length, consist of carbonate of lime, and are found imbedded in chalk, sand-stone, sand, and clay. Considerable doubts, respecting their nature, were entertained by mineralogists. Da Costa endeavours to prove, that they are not petrifactions, but merely minerals, which have accidentally assumed a particular shape*. But Mr. Baker, junior, described two belemnites, from a chalk-pit, near Norfolk; having, the one, an oyster-shell, and the other, two of those vermiculi commonly found on sea-shells, attached to it. Hence he infers, with considerable probability, that the belemnites themselves are marine productions †. Mr. Platt examined the subject with much attention, and has shewn, in a very convincing manner, that the belemnites are real marine petrifactions. He has rendered it probable, that they constitute a specie of nautilus; and, on that suppostition, has explained their formation in a satisfactory manner ‡. The belemnites occur very frequently in the coarser kinds of marble; and may be often seen, of considerable size, in old marble chimney-pieces. To the belemnites may be referred another similar petrifaction, the *orthoceratites*, which occurs likewise in marble §; and which is found at Kelwick, near Fulham ||.

Mnch curious information, respecting the occurrence of shells in the mineral kingdom, has been lately given to the public, by La Marke, and by Cuvier, and Brogniart ¶. These two last philosophers have given a most interesting description of the structure of the country round Paris; and have drawn some curious inferences from the alternate occurrence of fresh and salt-water shells, in different beds. Mr. Parkinson has given a similar account of the soil round London **; a subject, not so interesting as the country round Paris, from the different nature of the beds; but still possessed of considerable interest and importance.

3. *Bones*. The bones of animals, both sea and land, occur also

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* Phil. Trans. 1747. vol. xliv. p. 397.

† Phil. Trans. 1748. vol. xlv. p. 598.

‡ Phil. Trans. 1764. vol. liv. p. 38.

§ Wright. Phil. Trans. 1755. vol. xlix. p. 670.

|| Himsel. Phil. Trans. 1758. vol. l. p. 692.

¶ See the Annales de Museum d'Hist. Nat. passim.

** Transactions of the Geological Society of London, vol. i.

in considerable quantity in the mineral kingdom; though the quantity is by no means comparable to that of shells and zoophytes. Bones are seldom petrified; for they still retain their phosphate of lime, which constitutes, in some measure, their distinguishing character. But they have undergone a great change; for most commonly (though not always) they are destitute of their gelatinous and cartilaginous constituents, and are precisely in the same state as if they had been exposed to a red heat in the open air. The facts respecting mineral bones, detailed in the Transactions, possess considerable importance.

The head and horns of an unknown species of stag, much larger than any European species, is found abundantly under ground in Ireland, usually in a kind of marl. In one of these skeletons, measured by Molineux, the length, in a straight line, from the tip of one horn to that of another, was twelve feet. The horns were both palmated. Molineux conceived, that these skeletons belonged to the American moose deer*. But Pennant has shown, that it differs in various particulars from the head and horns of the moose; and that it belongs to a species of deer unknown in the live state, and probably extinct.

The bones of elephants have been found, at various times, scattered over most parts of Europe; a fact which has puzzled naturalists considerably, because the climate is at present too cold for these animals; and their remains, of course, seem to indicate some change in the nature of the earth, or, at least, in the climates. Much light has been thrown upon this obscure subject, by the anatomical knowledge of the Hunters, and, of late, by the indefatigable labours of Cuvier. These philosophers have demonstrated, that various bones, considered at first as belonging to elephants, certainly belong to an animal totally different from any species of elephant at present known. Cuvier has constituted this animal a peculiar genus, and more species of it than one seem formerly to have existed; though the whole genus appears to have been extinct, from a very remote period. Still, however, it can scarcely be doubted, that the bones of real elephants are occasionally dug up in various parts of Europe. The following examples are recorded in the Philosophical Transactions.

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* Phil. Trans. 1797 vol. xix. p. 489.

The skeleton of an enormous elephant, which is conceived to have been twenty-four feet high, was found in white sand at the bottom of a mountain in Thuringia *. Four elephants' teeth were dug up in Ireland. They were found about four feet under ground, near a small brook which divides the counties of Cavan and Monaghan †. The tusk of an elephant was dug up at the end of Gray's-inn-lane, London, and another in Northamptonshire, together with a grinder of the same enormous animal ‡. The bones of an elephant were found under-ground in the Isle of Sheppey on the sea coast. They speedily fell to powder when exposed to the air, but their size and shape had been previously ascertained §. Sir Hans Sloane endeavours to prove, and his proofs are pretty convincing, that the bones of supposed giants, found in various parts of the world, and described by different authors, were in reality elephants' bones ||.

Near the river Ohio, in America, at a place called the Great Buffalo Lick, a great number of bones belonging to some enormous animals were discovered at Croghan ¶. These were at first supposed to be elephants' bones. But Mr. John Hunter, having examined the teeth, pronounced them to belong to a carnivorous animal. Dr. Hunter published a dissertation on the subject, founded chiefly on his brother's observations **, and since that time they have been admitted to belong to some enormous unknown animal, and the name *mammoth*, applied to the bones of a large animal found in Siberia, has been applied to them. Cuvier has shown that the American and Siberian mammoth belong to different species. Some years ago a complete skeleton of the American mammoth was exhibited in London by Mr. Peale.

A vast collection of fossil bones have been found in the rock of Gibraltar. They were conceived to be human bones; but, Dr. Hunter having examined them, demonstrated that they belonged to a quadruped ††.

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* Tentzel. Phil. Trans. 1697. vol. xix. p. 757.

† Neville and Molineaux. Phil. Trans. 1715. vol. xxix. p. 367 and 370.

‡ Sloane. Phil. Trans. 1728. vol. xxxv. p. 457.

§ Jacob. Phil. Trans. 1754. vol. xlviii. p. 662.

|| Phil. Trans. 1728. vol. xxxv. p. 497.

¶ Phil. Trans. 1767. vol. lvii. p. 464.

** Phil. Trans. 1768. vol. lviii. p. 34.

†† Phil. Trans. 1770. vol. lx. p. 414.

A stag's head and horns were found at Matlock, Derbyshire, on a rock which, from the description of it given by Mr. Barker, seems to be calcareous tuffa *.

In the mountain of St. Peter, near Maestricht, were found in the year 1770, abundance of fossil bones, which Camper showed to belong to a kind of physeter †. A splendid work was afterwards published on these bones by Fojas de St. Fonde.

4. *Artificial Fossils.* There are few parts of Europe in which these are not to be occasionally met with: but they are peculiarly frequent in those countries which were at one time subject to the Roman yoke; and chiefly from the paved and durable roads which were so generally struck out from one station to another. Hence Great Britain is singularly rich in reliques of this description, and especially in Norfolk, Hampshire, Lincolnshire, and Yorkshire: while in Italy, whole streets and even towns have been laid open to the view of the antiquary, after having been buried for centuries and nearly chyliads of years beneath the rubbish of lava, pumice-stones, and other volcanic materials.

Of the more curious of these subterraneous discoveries, we shall now proceed to offer a few examples in regular order.

SECTION II.

FOSSIL PLANTS.

1. *On Subterranean Trees in Marshes bordering on the Thames. By the Rev. Mr. William Derham.*

ABOUT the year 1708, there happened an inundation at Dagenham and Havering marshes, in Essex, by a breach in the Thames wall, at an extraordinarily high tide; and by means of the great violence of the water, a large channel was torn up, or passage for the water, of one hundred yards wide, and twenty feet deep in some places; in some more, some less. By which means a great number of trees were laid bare, that had been buried there many ages before.

The trees were all of one sort, excepting only one, which was a

* Phil. Trans. 1715. vol. lxxv. p. 353.

† Phil. Trans. 1786. vol. lxxvi. p. 443.

large oak, with the greatest part of its bark on, and some of it heads and roots. The rest of the trees are by most persons taken to be yew; but a very ingenious gentleman convinced me they might more probably be some other wood, as alder, which grows plentifully by our fresh-water brooks, or else hornbeam; but I rather incline to the opinion of its being alder; the grain of the wood, and manner in which the boughs grow, &c. much resembling that of alder, more than hornbeam.

By lying so long under-ground, the trees are become black and hard, and their fibres are so tough, that one may as easily break a wire of the same size, as any of them. They maintain this toughness, if the wood be kept dry. But by drying, the trees become cracked, and very flawy within, but look sound outwardly, and with difficulty yield to wedges. But for the trees lying in the marshes, which are covered every flood, and laid bare every ebb, in a short time they became very rotten.

There is no doubt but those trees grew in the place where they now lie; and that in vast multitudes, as they lie so thick upon, or near each other, that in many places we could step from one to another. And there is great reason to think, that not only the marshes, which are now overflown, which are about a thousand acres, are stored with those subterraneous trees, but also all the marshes along by the river side, for several miles: for we discover these trees all along the Thames side, over against Rainham, Wennington, Purfleet, and other places: and in the breach that happened at West-Thorrock, about seventeen years earlier, they were washed out in as great numbers and of the same kind of wood, as those found lately in Dagenham and Havering Levels.

These last trees are of different sizes; some above a foot diameter, some less. As I was rowed in a boat along the channel, I met with two of the less sort, standing upright, in the same posture in which they grew; their tops just above low-water, and their bottoms, at least the bottom of the channel, at sixteen feet deep. We endeavoured to draw them out, but could not do it with all our strength. They seemed to be about two inches diameter in their trunk, had some of their boughs on, were dead, and probably, being young and light, escaped the force of what threw the other more large and unwieldy ones down. Most of the trees, that I met with, had their roots on, and many of them their boughs, and some a part of their

bark. There was only one that I perceived had any signs of the axe, and its head had been lopped off.

As I passed the channel which the water had torn up, I could see all along the shore vast numbers of the stumps of those subterraneous trees, remaining in the very same posture in which they grew, with their roots running some down, some branching and spreading about in the earth, as trees growing in the earth commonly do. Some of those stumps I thought had signs of the axe, and most of them were flat at top, as if cut off at the surface of the earth: but being rotten and battered, I could not fully satisfy myself, whether the trees had been cut or broken off.

The soil in which all those trees grew, was a black oozy earth, full of the roots of reed; on the surface of which oozy earth the trees lay prostrate, and over them a covering of grey mould, of the same colour and consistence with the dry sediment or mud, which the water leaves behind it at this day. This covering of grey earth is about seven or eight feet thick, in some places twelve feet or more, in some less; at which depths the trees generally lie. The trees lay in no kind of order, but some this way, some that way, and many of them across; only in one or two places I observed they lay more orderly, with their heads for the most part towards the north, as if they had been blown down by a southerly wind, which exerts a pretty considerable force on that shore.

As to the age in which those trees were interred, it is hard to determine. Many think they have lain in that state ever since Noah's flood. But though I have not the least doubt but that at this day there are many remains of the spoils of that deluge, even in the highest mountains, yet I rather think these trees to be the ruins of some later age, occasioned by some extraordinary inundations of the river Thames, or by some storms, which blow sharply on this shore. As for extraordinary inundations of the Thames, there is at this day a mark, which if occasioned by an inundation, must have been that of a prodigious one, beyond any ever known to have happened in that river; which is a bed of shells, if not of a kind of marble too, lying across the highway on the descent near Stifford-bridge, going to S. Okendon. Below this bed of shells, at above fifty or sixty yards distance, in the bottom of the valley, runs a brook, that empties itself into the Thames at Purfleet, about three miles from thence; which brook ebbs and flows with the Thames,

but not at any certain height, by reason of mills standing on it; but above a pretty high-water in the brook, the surface of the bed of shells lies more than 20 feet perpendicular. Consequently if this bed of shells was reposited in that place by an inundation of the Thames, it must be such as would have drowned a vast deal of the adjacent country, and have overtopped the trees near the river, in West-Thorrock, Dagenham, and the other marshes, and probably by that means overturn them.

For had these trees been left there by that deluge, we should not find the bed of earth, in which they grew, so entire and undisturbed, as it manifestly is at this day, a spongy, light, oozy soil, full of reed-roots, and of much less specific gravity than the stratum above it. Whereas I can from experiments affirm, that in three places where I have tried it, the strata are in a surprising manner, gradually specifically heavier and heavier, the lower and lower they lie.

As to the manner how these trees came to be interred, I take it to be from the gradual increase of the mud, or sediment, which every tide of the Thames left behind it. I presume those trees might be thrown down before the walls or banks were made, that now keep the Thames out of the marshes; and then they were covered every tide. And as they lay thick, and near each other on the ground, they would soon gather a great deal of the sediment, and be soon covered with it. And after the Thames-walls were made, every breach in them, and inundation, would leave great quantities of sediment behind it; as I by a troublesome experiment found, in going over some of the marshes, soon after the late breach, where I found the mud generally above my shoes, and in many places above my knees. And it is a practice among us, of which we have divers instances, that where a breach would cost more to stop, than the lands overflown will countervail, to leave the lands to the mercy of the Thames; which by gradually growing higher and higher, by the additions of sediment, will in time shut out the water of the river, all except the highest tides. And these lands they call saltings, when covered with grass; or else they become reed-grounds, &c.

That it was the sediment of the Thames that buried those trees, is further manifest from what was said before, of the likeness of the earth above them, in all respects, to the sediment the river now lets fall, when dry: which may be observed to consist of many distinct layers; some $\frac{9}{10}$ of an inch thick, some less, and some scarcely $\frac{1}{0}$ of

an inch; all which several layers are doubtless the several quantities which every tide left behind it. This sediment, when dried by the sun and wind, becomes tough and hard, and looks like a grey lapis scissilis, or slate, divisible into many plates or layers. And perhaps we may ascribe the conformation of slate, Muscovy-glass, and other such laminated concretions, to alike work of nature, by adding new layers of such petrifactions, and particles, as the fossil is formed of.

I presume there will be no doubt, but that the subterraneous wood receives its blackness from vitriolic juices in the earth. If any should doubt it, I have tried the experiment, and find that alder-wood, whether green or old, becomes blackish, much of the same colour as the wood above mentioned, in a solution of copperas. Which is not only an argument, that the blackness of the wood is owing to vitriol, but also that the wood is alder, or some such like wood, that will become black with vitriol: for I am informed that all subterraneous wood is not black, particularly fir. I have also tried hornbeam since, after the same manner, and find that also becomes black, as the alder does.

[*Phil. Trans.* 1712]

2. *On a Submarine Forest in Hatfield Chace, Yorkshire. By the Rev. Abraham De la Pryme.*

THE famous levels of Hatfield Chace, in Yorkshire, were the largest chase of red deer that King Charles the First had in all England, containing in all, above 180,000 acres of land, about half of which was yearly drowned by vast quantities of water. This being sold to one Sir Cornelius Vermuiden, a Dutchman, he at length effectually dischased, drained, and reduced it to constant arable and pasture grounds, and at the immense labour and expence of above 400,000 *l.* In the soil of all, or most of the said 180,000 acres of land, of which 90,000 were drained, even in the bottom of the river Ouse, and in the bottom of the adventitious soil of all Marshland, and round about by the skirts of the Lincolnshire Would, unto Gainsburg, Bautry, Doncaster, Baln, Snaith and Holden, are found vast multitudes of the roots and trunks of trees of all sizes, great and small, and of most of the sorts that this island either formerly did, or that at present it does produce; as firs, oaks, birch, beech, yew, thorn, willow, ash, &c. the roots of

all or most of which, stand in the soil in their natural position, as thick as ever they could grow, as the trunks of most of them lye by their proper roots. Most of the large trees lie along about a yard from their roots, (to which they evidently belonged, both by their situation, and the sameness of the wood,) with their tops commonly north-east; though indeed the smaller trees lie almost every way, across the former, some over, and others under them; a third part of all being pitched trees, or firs, some of which are 30 yards in length and upwards, and sold for masts and keels for ships. Oaks have been found of 20, 30, and 35 yards long, yet wanting many yards at the small end; some of which have been sold for 4, 8, 10, and 15 *l.* a piece; they are as black as ebony, and very durable in any service they are put to. As for the ashes, it is commonly observed, that the constituent parts of their texture are so dissolved, that they become as soft as earth, and are commonly cut in pieces by the workmen's spades, which, as soon as flung up into the open air, crumble into dust; but all the rest, even the willows themselves, which are softer than ash, preserve their substance and texture entire to this day. I have seen some fir trees, that as they have laid all along, after they were fallen, have shot up large branches from their sides, which have grown-up to the bulk and height of considerable trees.

It is very observable, and manifestly evident, that many of those trees of all sorts have been burnt, but especially the pitch or fir trees, some quite through, and some all on a side; some have been found chopped and squared, some bored through, others half split with large wooden wedges and stones in them, and broken axe-heads, somewhat like sacrificing axes in shape, and all this in such places, and at such depths, as could never be opened, since the destruction of this forest, till the time of the drainage. Near a large root in the parish of Hatfield, was found 8 or 9 coins of some of the Roman emperors, but exceedingly consumed and defaced with time; and it is very observable, that on the confines of this low country, between Burningham and Brumby in Lincolnshire, are several great hills of loose sand, under which, as they are yearly worn and blown away, are discovered many roots of large firs, with the marks of the axe as fresh upon them, as if they had but been cut down only a few weeks; as I have often with pleasure seen.

Hazle nuts and acorns have frequently been found at the bottom

of the soil of those levels and moors, and whole bushels of fir-tree apples, or cones, in large quantities together; and at the very bottom of a new river or drain, (almost 100 yards wide, and 4 or 5 miles long,) were found old trees squared and cut, rails, stoops, bars, old links of chains, horse-heads, an old axe, somewhat like a battle-axe, two or three coins of the emperor Vespasian, one of which I have seen in the hands of Mr. Cornelius Lee of Hatfield, with the emperor's head on one side, and a spread eagle on the other; but what is more remarkable is, that the very ground at the bottom of the river, was found in some places to lie in ridges and furrows, thereby showing that it had been ploughed and tilled in former days.

My friend Mr. Edward Canby told me that about 50 years ago, under a great tree in this parish was found an old fashioned knife, with a haft of a very hard black sort of wood, which had a cap of copper or brass on the one end, and a hoop of the same metal on the other end, where the blade went into it. He also found an oak tree within his moors, 40 yards along, 4 yards diametrically thick at the great end, 3 yards and a foot in the middle, and 2 yards over at the small end; so that by moderate computation, the tree seems to have been as long again. At another time he found a fir-tree, 36 yards long, besides its computed length, which might well be 15 yards more. So that there has been exceedingly great trees in these levels; and what is also very strange, about 50 years ago, at the very bottom of a turf-pit, there was found a man lying at his length, with his head upon his arm, as in a common posture of sleep, whose skin being tanned as it were by the moor water, preserved his shape entire, but within, his flesh, and most of his bones were consumed.

To illustrate and render more intelligible this strange subject of subterraneous trees, we may here advert a little to what has been observed in other places and countries. Camden and others have told us, and it is a very common and well known thing, that most of the great morasses, mosses, fens, and bogs, in Somersetshire, Cheshire, Lancashire, Westmoreland, Yorkshire, Staffordshire, Lincolnshire, and other counties in England, are full of the roots and trunks of large trees, most of which are pitch or fir, and that they have the same positions and impressions of the fire and axe on them, as those above-mentioned.

Giraldus Cambrensis tells us, that in King Henry the 2d's days, by the force of extraordinary storms, the sands were so much driven off the sea-shore in Pembrokeshire, that under them were discovered great numbers of roots and trunks of trees in their natural positions, with the strokes of the axe as fresh upon them, as if they had been cut down only yesterday, with a very black earth, and some blocks like ebony. And the like were discovered also at Neugall, in the same county, in 1590, and in Cardiganshire, and in other places since.

Dr. Plot mentions the like roots and trees, found in Shebben-Pool, the old Pewitt-Pool, and at Layton, and other places in Staffordshire; and from their natural situations he rightly concludes, that they certainly grew there.

Dr. Leigh, in his history of Cheshire, observes, that in draining Martin Meer, there was found multitudes of the roots and trunks of large pitch trees, in their natural positions, with great quantities of their cones, and 8 canoes, such as the old Britons sailed in; and in another moor was found a brass kettle, beads of amber, a small mill-stone, the whole head of a hippopotamus, and human bodies entire and uncorrupted, as to outward appearance. Many places too of the soil of Anglesea and Mann, as also of the bogs of Ireland, are likewise full of roots and trees.

As to other countries, Verstegan tells us, that in many places of the moors and morasses of the Netherlands, large fir-trees are commonly found, with their tops lying to the north east, just as they do in the levels of Hatfield-chase. And Helmont mentions the Peel there, a moss more than 9 miles broad. Also M. De la Fer says, that trees and roots are also frequently found in the low grounds; and in the levels and morasses of France, Switzerland, and Savoy. And lastly, Rammazzini assures us, that in the territories of Modena, which are several miles long and broad, and at present a most fruitful dry country, though in the time of the Cæsars it was nothing but a great lake, are found at 30, 40, and 50 feet deep, the soil of a low marshy country, full of sedge, reeds, shrubs, roots, trees, nuts, ears of corn, leaves of trees, branches and boughs of oaks, elms, walnuts, ashes, willows, and the very trees themselves, some broken, some whole, some standing upright, some lying at their length, &c. with old coins of the Roman emperors,

old marbles and stones squared, cut, carved and wrought with the hands of men, &c.

But now, seeing that we find roots and trees, with other things that are common to these levels, not only there, but also in other countries, it yet remains to inquire, how all this comes to pass, and what reasons and causes can be given for it. I know, that most men are for referring all this to Noah's flood. But if so, how comes it, that the trees and their roots lie so near each other, and why lengthwise, from south west to north east? Why some of them burnt, others chopped, some split, others squared, and some bored through? Why the soil at the very bottom of a large river lie in ridge and furrow, and why are the coins of the Roman emperors found in those places, &c.? For me, I humbly conceive, that all those trees grew in the very places where they are now found, both in this country and elsewhere. Against which, I know of only two objections of any consequence. 1. That Cæsar expressly says, that no fir-trees in his time grew in Britain. But this is nothing at all to the purpose: for those trees that are called firs by the vulgar, from their near conformity and likeness to that tree, are well known by all learned men, by the redness, the resinous nature of the wood, the gracile cones hanging downwards, &c. to be the true pitch-tree, of which there are such great plenty in Norway, Sweden, and other countries of the north, and of which there are whole woods at this very day in Scotland, and upon a hill at Wareton, in Staffordshire, they grow wild to the present time. Also in an old deed relating to this very chace, fir-trees or bushes are mentioned as growing here and there, about 300 years since.

2. That those sorts of trees grow always on high mountains and rocks, and never thrive on such low grounds and morasses, as these are, where we now find them buried. But though they do, in all cold countries of the north, thrive best on the hardest rocks and mountains, yet are they sometimes seen even large and plentiful in the low morasses of Liefland, Courland, Pomerania, and other countries thereabouts; and in the low forests and woods; for the truth is, that these stately trees chiefly delight to grow in a sandy soil; and if it lie never so high, or never so low, there they will grow, and there it is natural to them. It was lately observed in digging the pit of a great decoy in these levels, that the roots of the firs always

stood in the sand, and the oaks in the clay; and I have observed the same in multitudes of places of these commons.

Thus, as all those great and stately trees flourished here, and composed one of the largest and most beautiful forests in all the country; so in the next place, I shall enquire how it came to be destroyed, and for what reasons and causes it was so. All this may be known by searching into the ancient Roman writers and historians: who frequently tell us, when their armies and generals pursued the wild Britons, that they always fled into the fastnesses of miry woods and low watery forests. Cæsar himself confesses the same, and says, that Cassibelen and his Britons, after their defeat passed the Thames, and fled into such low morasses and woods, that there was no possibility of following them. We also find that the stout nation of the Silures did the same, when they were set-upon by Ostorius and Agricola. The like did Venutius king of the Brigantes, who fled into the great woody morasses of this country, and perhaps into those very same that formerly overspread these levels. And Herodian plainly tells us, that it was the custom of the wild Britons to keep in the fenny bogs and thick marshy woods; and when opportunity offered, to issue out and fall upon the Romans, who were at length so plagued with them, that they were forced to issue out orders for the destroying and cutting down of all the woods and forests in Britain, especially of all those that grew upon low grounds and morasses. This order, I think, is mentioned in Vopiscus; and that they were thereupon accordingly cut down, is evident from many writers, who tell us, that when Suetonius Paulinus conquered Anglesea, he cut down all the woods there. Galen tells us, that the Romans kept their soldiers continually employed in cutting down woods, draining marshes and fens, and in paving bogs. It is also manifest, that they not only did this themselves, but also imposed the same heavy task on captive Britons; for Galgacus, in his speech to his soldiers, tells them, that the Romans made slaves of them, and wore out their bodies in cutting down woods, and in cleansing bogs, amidst a thousand stripes and indignities; and Dion Cassius tells us, that the emperor Severus lost 50,000 of his men in a few years time, in cutting down the woods, and cleansing the fens and morasses of the country.

Now all that has been said, may I think sufficiently prove, that the Romans were the destroyers of all those great woods and forests,

which we now find under-ground in the bottoms of moors and bogs; and that they actually were in this part of the country, and destroyed this great and beautiful one, of stately firs, that overspread all those vast levels, and the country round about, I come now more particularly to show and prove.

The common road of the Romans out of the south into the north, was formerly from Lindum or Lincoln, to Segelocum, or Little-Burrow upon Trent, and from thence to Danum or Doncaster, where they kept a standing garrison of Crispinian horse. A little off, to the east and north-east of this road, between the two last-named towns, lay the borders of the great forest, which swarmed with wild Britons, who were continually sallying out, and retreating into it again, intercepting their provisions, taking and destroying their carriages, killing their allies and passengers, and disturbing their garrisons; which at length so enraged the Romans, that they were resolved to destroy it; and that they might do the same more effectually, as well as the more easily, they marched with a great army, and encamped on a large heath or moor, not far from Finningly, (as appears by their fortifications still to be seen there) where it is probable that a great battle ensued, for hard by is a little town called Osterfield. Now as the latter part of the word is never used to be added to any other, but where there has been a battle; so the former seems to inform us what Roman general it was that commanded, to wit, the famous Ostorius, whom all the Roman historians assure us was in those parts. But who got the victory is not directly mentioned, though no doubt it was the valiant Romans, who besides the multitudes of the Britons they slew, drove the rest back into the great forest and wood, that covered all this low country. Whereupon the Romans, that they might both destroy it and the enemy the easier, took the opportunity of a strong south-west wind, and set great fires therein, which taking hold of the fir-trees, burned like pitch, and consumed immense numbers of them; and, when the fire had done what mischief and execution it could, the Romans brought their army nearer, and with whole legions of captive Britons chopped and cut down most of the trees that were yet left standing, leaving only here and there some large ones untouched, as monuments of their fury; which being destitute of the support of the under-wood, and of their neighbouring trees, were easily overthrown by strong winds. All which trees falling cross the rivers that formerly ran

through this low country, soon dammed them up, and turned it into a large lake, and gave origin to the great turf moors that are here, by the girations and workings of the waters, the precipitation of terrestrial matter from them, the consumption and putrefaction of decayed boughs and branches, and the vast increase of thick water moss, which wonderfully flourishes and grows upon such rotten grounds. Which even now since the drainage, and since that the country is laid dry for many miles round about, yet for all that, are so turgid with water, and so soft and rotten, that they will scarcely bear men to walk upon them.

Hence it is, that old Roman coins, old Roman axe-heads, &c. have been found near those roots and trees, that lie at the bottom of these moors and levels. Hence it is, that in all these grounds are found great numbers of trees that are burned, some in two, and some lengthwise, others hewn and chopped. Hence it is, that they lie near their own roots, with their tops north-east. Hence it is that some of the greatest trees are found with their roots on, and others as they have laid all along have had branches growing out of their sides, to the thickness and height of considerable trees. Hence it is that both the clay and moor soil of the country, is in some places two or three yards higher than it was formerly, by the growing up of the same, and the daily warp that the rivers continually cast thereon, &c.

But to return; as the Romans were the destroyers of this great forest, so were they likewise of all those others that formerly grew on the low countries of Cheshire, Lancashire, Yorkshire, Lincolnshire, Staffordshire, Somersetshire, &c. and also of the very countries before-mentioned beyond sea, where such-like trees are found. But as the Romans were not much in Wales, the Isle of Man, nor Ireland, so it cannot be supposed that they cut down their woods; but yet others did: for Hollinshed and others of our historians tell us, that Edward the First not being able to get near the Welch to fight them, by their continuance and skulking in boggy woods, commanded them all to be detroyed by fire and the axe: and I doubt not at all but that the roots and trees, before-mentioned by Cambrensis in Pembrokeshire, were the relics of some of those that were then destroyed: and as for those in Man and other islands, they have all been cut down in time of war, and have lain till they were grown over with the soil of the neighbouring grounds; and as

for those that are found in the bogs of Ireland, several of our historians expressly say, that Henry the Second, when he conquered it, cut down all the woods that grew on the low countries there, the better to secure his conquest and possession of it, to keep the country in a settled peace, and to disarm the enemy, who commonly trusting to such advantages are apt to rebel. I will only add, that it is a very common thing for generals and armies, even to this very day, to destroy all the woods that grow upon advantageous places, and fastnesses, in an enemy's country, if they intend to keep it; and that they always do it with fire and axe.

[*Phil. Trans.* 1701.]

3. *On the Cause of Fossil Vegetables; with Remarks on the preceding. By Joseph Correa de Serra, L.L.D. F.R.S. A.S.*

It was a common report in Lincolnshire, that a large extent of islets of moor, situated along its coast and visible only at the lowest ebbs of the year, was chiefly composed of decayed trees. These islets are marked in Mitchell's chart of that coast, by the name of clay huts; and the village of Huttoft, opposite to which they principally lie, seems to have derived its name from them. In the month of September 1796, I went to Sutton, on the coast of Lincolnshire, in company with Sir Joseph Banks, to examine their extent and nature. The 19th of the month, being the first day after the equinoctial full moon, when the lowest ebbs were to be expected, we went in a boat, at half past twelve at noon, and soon after set foot upon one of the largest islets then appearing. Its exposed surface was about thirty yards long, and twenty-five wide, when the tide was at the lowest. A great number of similar islets were visible round us, chiefly to the eastward and southward; and the fishermen, whose authority on this point is very competent, say, that similar moors are to be found along the whole coast, from Skegness to Grimsby, particularly off Addlethorpe and Mablethorpe. The channels dividing the islets were, at the time we saw them, wide, and of various depths; the islets themselves ranging generally from east to west in their largest dimension.

We visited them again in the ebbs of the 20th and 21st; and, though it generally did not ebb so far as we expected, we could notwithstanding ascertain, that they consisted almost entirely of roots, trunks, branches, and leaves of trees and shrubs, intermixed

with some leaves of aquatic plants. The remains of these trees were still standing on their roots; while the trunks of the greater part lay scattered on the ground, in every possible direction. The bark of the trees and roots appeared generally as fresh as when they were growing; in that of the birches particularly, of which a great quantity was found, even the thin silvery membranes of the outer skin were discernible. The timber of all kinds, on the contrary, was decomposed and soft, in the greatest part of the trees; in some however it was firm, especially in the knots. The people of the country have often found among them very sound pieces of timber, fit to be employed for several economical purposes.

The sorts of wood which are still distinguishable, are birch, fir, and oak. Other woods evidently exist in these islets, of some of which we found the leaves in the soil; but our present knowledge of the comparative anatomy of timbers, is not so far advanced as to afford us the means of pronouncing with confidence respecting their species. In general, the trunks, branches, and roots of the decayed trees, were considerably flattened; which is a phenomenon observed in the Surtarbrand or fossil wood of Iceland, and which Scheuchzer remarked also in the fossil wood found near the lake of Thun, in Switzerland. The soil to which the trees are affixed, and in which they grew, is a soft greasy clay; but, for many inches above its surface, the soil is entirely composed of rotten leaves, scarcely distinguishable to the eye, many of which may be separated, by putting the soil in water, and dexterously and patiently using a spatula, or blunt knife. By this method, I obtained some perfect leaves of ilex aquifolium, which are now in the herbarium of Sir Joseph Banks; and some other leaves which, though less perfect, seem to belong to some species of willow. In this stratum of rotten leaves, we could also distinguish several roots of arundo phragmites.

These islets, according to the most accurate information, extend at least twelve miles in length, and about a mile in breadth, opposite Sutton shore. The water without them, towards the sea, generally deepens suddenly, so as to form a steep bank. The channels between the several islets, when the islets are dry, in the lowest ebbs of the year, are from four to twelve feet deep; their bottoms are clay or sand, and their direction is generally from east to west. A well dug a Sutton, by Joseph Searby, shows that a moor of the same nature is found under-ground, in that part of the country, at

the depth of sixteen feet; consequently, very nearly on the same level with that which constitutes the islets. The disposition of the strata was found to be as follows:

Clay - - - - -	16 feet
Moor, similar to that of the islets -	from 3 to 4 ditto
Soft moor, like the scowerings of a ditch bottom, mixed with shells and silt - -	20 ditto
Marly clay - - - -	1 foot
Chalk rock - - -	from 1 to 2 feet
Clay - - - - -	31 yards
Gravel and water; the water has a chalybeate taste.	

In order to ascertain the course of this subterraneous stratum of decayed vegetables, Sir Joseph Banks directed a boring to be made, in the fields belonging to the Royal Society, in the parish of Mablethorpe. Moor, of a similar nature to that of Searby's well, and of the islets, was found, very nearly on the same level, about four feet thick, and under it a soft clay.

The whole appearance of the rotten vegetables we observed, perfectly resembles, according to the remark of Sir Joseph Banks, the moor which, in Blankeney fen, and in other parts of the East fen in Lincolnshire, is thrown up in the making of banks; barks, like those of the birch tree, being there also abundantly found. This moor extends over all the Lincolnshire fens, and has been traced as far as Peterborough, more than sixty miles to the South of Sutton. On the north side, the moory islets, according to the fishermen, extend as far as Grimsby, situated on the south side of the mouth of the Humber; and it is a remarkable circumstance, that in the large tracts of low lands which lie on the south banks of that river, a little above its mouth, there is a subterraneous stratum of decayed trees and shrubs, exactly like those we observed at Sutton; particularly at Axholme isle, a tract of ten miles in length, by five in breadth; and at Hatfield chase, which comprehends one hundred and eighty thousand acres. Dugdale * has long ago made this observation, in the first of these places; and De la Pryme † in the second. The roots are there likewise standing in the places where they grew; the trunks lie prostrate. The woods are of the same species as at

* History of Embanking and Draining, chap. 27.

† Phil. Trans. vol. xxii. p. 980.

Sutton. Roots of aquatic plants and reeds are likewise mixed with them; and they are covered by a stratum of some yards of soil, the thickness of which, though not ascertained with exactness by the above-mentioned observers, we may easily conceive to correspond with that which covers the stratum of decayed wood at Sutton, by the circumstance of the roots being according to Mr. Richardson's observations *, only visible when the water is low, where a channel was cut, which has left them uncovered.

Little doubt can be entertained of the moory islets of Sutton being a part of this extensive subterraneous stratum, which, by some inroad of the sea, has been there stripped of its covering of soil. The identity of the levels; that of the species of trees; the roots of these affixed, in both to the soil where they grew; and, above all, the flattened shape of the trunks, branches, and roots, found in the islets, which can only be accounted for by the heavy pressure of a superinduced stratum, are sufficient reasons for this opinion. Such a wide spread assemblage of vegetable ruins, lying almost in the same level, and that level generally under the common mark of low water, must naturally strike the observer, and give birth to the following questions. 1. What is the epoch of this destruction? 2. By what agency was it effected? In answer to these questions, I will venture to submit the following reflections.

The fossil remains of vegetables hitherto dug up in so many parts of the globe, are, on a close inspection, found to belong to two very different states of our planet. The parts of vegetables, and their impressions, found in mountains of a cotaceous †, schistous, or even sometimes of a calcareous nature, are chiefly of plants now existing between the tropics, which could neither have grown in the latitudes in which they are dug up, nor have been carried and deposited there by any of the acting forces under the present constitution of nature. The formation indeed of the very mountains in which they are buried, and the nature and disposition of the materials which compose them, are such as we cannot account for by any of the actions and re-actions which, in the actual state of things, take place on the surface of the earth. We must necessarily recur to that period in the history of our planet, when the surface of the ocean was at least so much above its present level, as to cover even the summits of these

* Phil. Trans. vol. xix. p. 528.—Orig.

† Arenaceous, or sandy; from *cos, cotis*, Lat.—*Edit.*

secondary mountains which contain the remains of tropical plants. The changes which these vegetables have suffered in their substance is almost total; they commonly retain only the external configuration of what they originally were. Such is the state in which they have been found in England, by Llwyd; in France by Jessieu; in the Netherlands, by Burtin; not to mention instances in more distant countries. Some of the impressions or remains of plants found in soils of this nature, which were, by more ancient and less enlightened oryctologists, supposed to belong to plants actually growing in temperate and cold climates, seem, on accurate investigation, to have been parts of exotic vegetables. In fact, whether we suppose them to have grown near the spot where they are found, or to have been carried thither from different parts, by the force of an impelling flood, it is equally difficult to conceive, how organized beings, which, in order to live, require such a vast difference in temperature and in seasons, could live on the same spot, or how their remains could, from climates so widely distant, be brought together to the same place, by one common dislocating cause. To this ancient order of fossil vegetables belong whatever retains a vegetable shape, found in or near coal mines, and, to judge from the places where they have been found, the greater part of the agatized woods. But, from the species and present state of the trees which are the subject of this Memoir, and from the situation and nature of the soil in which they are found, it seems very clear that they do not belong to this primeval order of vegetable ruins.

The second order of fossil vegetables, comprehends those which are found in strata of clay or sand; materials which are the result of slow depositions of the sea or of rivers, agents still at work under the present constitution of our planet. These vegetable remains are found in such flat countries as may be considered to be of a new formation. Their vegetable organization still subsists, at least in part; and their vegetable substance has suffered a change only in colour, smell, or consistence; alterations which are produced by the developement of their oily and bituminous parts, or by their natural progress towards rottenness. Such are the fossil vegetables found in Cornwall, by Borlase; in Essex, by Derham; in Yorkshire, by De la Pryme, and Richardson; and in foreign countries by other naturalists. These vegetables are found at different depths, some of them much below the present level of the sea, but in clayey

or sandy strata, evidently belonging to modern formation, and have, no doubt, been carried from their original place, and deposited there by the force of great rivers or currents, as it has been observed with respect to the Mississippi.* In many instances, however, these trees and shrubs are found standing on their roots, generally in low or marshy places, above, or very little below, the actual level of the sea.

To this last description of fossil vegetables, the decayed trees here described certainly belong. They have not been transported by currents or rivers; but, though standing in their native soil, we cannot suppose the level in which they are found, to be the same as that in which they grew. It would have been impossible for any of these trees and shrubs to vegetate so near the sea, and below the common level of its water; the waters would cover such tracts of land, and hinder any vegetation. We cannot conceive that the surface of the ocean has ever been lower than it now is, on the contrary, we are led by numberless phænomena to believe, that the level of the waters in our globe is much below what it was in former periods; we must therefore conclude, that the forest here described grew in a level high enough to permit its vegetation; and that the force, whatever it was, which destroyed it, lowered the level of the ground where it stood.

There is a force of subsidence, particularly in soft ground, which, being a natural consequence of gravity, slowly though perpetually operating, has its action sometimes quickened and rendered sudden by extraneous causes, for instance, by earthquakes. The slow effects of this force of subsidence have been accurately remarked in many places; examples also of its sudden action are recorded in almost every history of great earthquakes. The shores of Alexandria, according to Dolomieu's observations, are a foot lower than they were in the time of the Ptolemies. Donati, in his Natural History of the Adriatic, has remarked, seemingly with great accuracy, the effects of this subsidence at Venice; at Pola, in Istria; at Lissa, Bua, Zara, and Diclo, on the coast of Dalmatia. In England, Borlase has given, in the Phil. Trans. vol. 48, p. 62, a curious observation of a subsidence, of at least sixteen feet, in the ground between Sampson and Trescaw islands, in Scilly. The soft and low ground between the towns of Thorne and Gowle, in Yorkshire, a space of many miles,

* La Coudreniere sur les Depots du Mississippi. Journ. de Phys. vol. 21, p. 230.—Orig.

has so much subsided in latter times, that some old men of Thorne affirmed, "that whereas they could before see little of the steeple of Gowle, they now see the churchyard wall *." The instances of similar subsidence which might be mentioned, are innumerable.

This force of subsidence, suddenly acting by means of some earthquake, seems the most probable cause to which the actual submarine situation of the forest we are speaking of may be ascribed. It affords a simple easy explanation of the matter; its probability is supported by numberless instances of similar events; and it is not liable to the strong objections which exist against the hypothesis of the alternate depression and elevation of the level of the ocean; an opinion which, to be credible, requires the support of a great number of proofs, less equivocal than those which have hitherto been urged in its favour, even by the genius of a Lavoisier †.

The stratum of soil, sixteen feet thick, placed above the decayed trees, seems to remove the epoch of their sinking and destruction, far beyond the reach of any historical knowledge. In Cæsar's time, the level of the North Sea appears to have been the same as in our days. He mentions the separation of the Wahal branch of the Rhine, and its junction to the Meuse; noticing the then existing distance from that junction to the sea; which agrees, according to D'Anville's inquiries,‡ with the actual distance. Some of the Roman roads constructed by order of Augustus, under Agrippa's administration, leading to the maritime towns of Belgium, still exist, and reach the present shore §. The descriptions which Roman authors have left us, of the coasts, ports, and mouths of rivers, on both sides of the North Sea, agree in general with their present state; except in the places ravaged by the inroads of this sea, more apt, from its form, to destroy the surrounding countries, than to increase them.

An exact resemblance exists between maritime Flanders and the opposite low coast of England, both in point of elevation above the sea, and of internal structure and arrangement of their soils. On both sides, strata of clay, silt, and sand, often mixed with decayed

* Gough's edition of Camden's Britannia, t. 3, p. 35.

† Mém de l'Acad. de Paris, 1789, p. 351.

‡ D'Anville Notice des Gaules, p. 461.—Orig.

§ Nicol. Bergier Hist. des grands Chemins des Romains. Ed. de Bruxelles. vol. 2, p. 169.—Orig.

vegetables, are found near the surface; and in both, these superior materials cover a very deep stratum of bluish or dark-coloured clay, unmixed with extraneous bodies. On both sides, they are the lowermost part of the soil, existing between the ridges of high lands*, on their respective sides of the same narrow sea. These two countries are certainly coeval; and whatever proves that maritime Flanders has been for many ages out of the sea, must, in my opinion, prove also, that the forest we are speaking of was long before that time destroyed, and buried under a stratum of soil. Now it seems proved, from historical records, carefully collected from several learned members of the Brussels academy, that no material change has happened to the lowermost part of maritime Flanders, during the period of the last two thousand years †.

I am therefore inclined to suppose the original catastrophe which buried this forest, to be of a very ancient date; but I suspect the inroad of the sea which uncovered the decayed trees of the islets of Sutton, to be comparatively recent. The state of the leaves and of the timber, and also the tradition of the neighbouring people, concur to strengthen this suspicion. Leaves and other delicate parts of plants, though they may be long preserved in a subterraneous situation, cannot remain uninjured, when exposed to the action of the waves and of the air. The people of the country believe, that their parish church once stood on the spot where the islets now are, and was submerged by the inroads of the sea; that, at very low water, their ancestors could even discern its ruins; that their present church was built to supply the place of that which the waves washed away; and that even their present clock belonged to the old church. So many concomitant, though weak testimonies, incline me to believe their report, and to suppose that some of the stormy inundations of the North Sea, which in these last centuries have washed away such large tracts of land on its shores, took away a soil resting on clay, and at last uncovered the trees which are the subject of this paper.

[*Phil. Trans.* 1799.]

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* These ridges of high land, both on the British and Belgic side, must be very similar to each other, since they both contain parts of tropical plants in a fossil state. Cocoa nuts, and fruits of the areca, are found in the Belgic ridge. The petrified fruits of Sheppey, and other impressions of tropical plants, on this side of the water, are well known.

† Vide several papers in the Brussels Mémoires; also Journ. de Phys. t. 34, p. 401.—Orig.

SECTION III.

Fossil Animal Remains.

On Subterranean Horns of an enormous size frequently found in Ireland. By Thomas Molyneux, M. D. F. R. S.

BY the remains we have of this animal, it appears to have been of the genus cervinum or deer kind, and of that sort that carries broad or palmed horns, bearing a greater affinity with the buck or fallow deer, than with the stag or red deer, that has horns round and branched without a palm: this I lately observed, having an opportunity of particularly examining a complete head, with both its horns entirely perfect, not long since dug up, given to my brother William Molyneux, as a natural curiosity, by Mr. Henry Osborn, of Dardistown, in the county of Meath, about two miles from Drogheda, who wrote him the following account of the manner and place they were found in.

"I have by the bearer sent the head and horns I promised you; this is the third head I have found by casual trenching in my orchard; they were all dug up within the compass of an acre of land, and lay about four or five feet under ground, in a sort of boggy soil. The first pitch was of earth, the next two or three of turf, and then followed a sort of white marl, where they were found: they must have lain there several ages, to be so deeply interred."

I took their dimensions carefully as follows: from the extreme tip of the right horn to that of the left, was ten feet ten inches; from the tip of the right horn to the root where it was fastened to the head, five feet two inches; from the tip of the highest branch, measuring one of the horns transverse, or directly across the palm, to the tip of the lowest branch, three feet seven inches and a half. The length of one of the palms within the branches, two feet six inches: the breadth of the same palm, still within the branches, one foot ten inches and a half: the branches that shot forth round the edge of each palm were nine in number, besides the brow-antlers, of which the right antler was a foot and two inches in length, the other was much shorter: the beam of each horn at some distance from the head, was about two inches and six tenths of an inch in diameter, or about eight inches in circumference; at the root, where it was fastened to the head, about eleven inches in circumference. The length of the head, from the back of the skull to the tip of the nose,

or rather the extremity of the upper jaw-bone, two feet, the breadth of the skull, where largest, was a foot.

The two holes near the roots of the horns, that look like eyes were not so, (for these were placed on each side the head in two ample cavities), but were large open passages, near an inch in diameter in the forehead bone, to give way to great blood-vessels that here issue forth from the head, and pass between the surface of the horn, and the smooth hairy skin that covers them whilst they are growing, (which is commonly called the velvet) to supply the horns with sufficient nourishment, while they are soft, and till they arrive at their full magnitude, so as to become perfectly hard and solid.

It is not to be questioned, but these spacious horns, like others of the deer kind, were naturally cast every year, and grew again to their full size in about the space of four months: for all species of deer, yet known, certainly drop their horns yearly, and with us it is about March, and about July following they are full grown again. And this probably owing to the same cause that trees annually cast their ripe fruit, or drop their withering leaves in autumn; that is, because the nourishing juice is stopped, and flows no longer; either on the account that it is now deficient, being all spent, or that the hollow passages, which convey it, dry up, so that the part having no longer any communication with them must of necessity by degrees sever from the whole.

Another such head, with both the horns entire, was found some years since by one Mr. Van Delure, in the county of Clare, buried ten feet under ground in a sort of marl. And, in the year 1691, Major Folliot told me, that digging for marl near the town Bally-mackward, not far from Ballyshannon, in the county of Fermanagh, he found buried, ten feet under plain solid ground, a pair of this sort of horns, which he keeps still in his possession. In the year 1684, two of these heads were dug up near Turvy, within eight miles of Dublin. Not long since, a head of this kind, with its horns, was found near Portumny, the house of the earls of Clanricarde, seated on the river Shannon, in the county of Galway. And to my knowledge, within less than twenty years, above twenty, I might safely say thirty, pair of such horns have been dug up in several places of this country, all found by accident; and we may well suppose vast numbers still remain undiscovered; so that doubtless this creature was formerly common in Ireland, and an indigenous ani-

mal, not peculiar to any territory or province, but universally met with in all parts of the kingdom. We may also reasonably gather, that they were not only common in this country, but that they were a gregarious animal, or such a sort of creature as affect naturally keeping together in herds; several of these heads being found within a small compass.

That these heads should be constantly found buried in a sort of marl, seems to intimate, as if marl was only a soil that had been formerly the outward surface of the earth, but in process of time, being covered by degrees with many layers of adventitious earth, has by lying under-ground a certain number of ages; acquired a peculiar texture, consistence, richness, or maturity, that gives it the name of marl; for we must needs allow that the place where these heads are now found, was certainly once the external superficies of the ground; otherwise it is hardly possible to conceive how they should come there. And that they should be so deep buried, as we at present find them, appears to have happened by their accidentally falling where it was soft low ground; so that the horns, by their own considerable gravity, might easily make a bed, where they settled in the yielding earth; and in a very long course of time, the higher lands being by degrees dissolved by repeated rains, and washed and brought down by floods, covered those places that were situated lower with many layers of earth: for all high grounds and hills, unless they consist of rock, by this means naturally lose a little every year of their height; and sometimes sensibly become lower even in one age.

How this kind of animals, formerly so common and numerous in this country, should now become utterly lost and extinct, deserves our consideration. Some have been apt to imagine that they were destroyed by the deluge in Noah's time. But it is not probable that such a slight and porous substance as these horns could be preserved entire from the time of that flood. It is indeed more likely that this animal might be destroyed here by some epidemic distemper, or pestilential murrain.

It remains that we inquire, what species of animal it was to which these enormous horns belonged. It is an opinion generally received that they belonged to the alche, elche, or elenda, and therefore they are usually called elks' horns. But they are quite different from these, both in shape and in size, and cannot by any means be-

long to the same animal. Indeed the description of that majestic horned animal in America, called the moose, or moose-deer, agrees sufficiently well with it; having the same sort of palmated horns, of similar length and breadth, as well as figure, and the bulk of their bodies corresponding exactly in proportion to the wide spreading of their horns. So that it may be concluded that the moose deers were formerly as frequent in Ireland as they are still in the northern parts of the West-Indies, New-England, Virginia, Maryland, and Canada.

This animal I find described by Mr. John Josselyn among his New-England rarities, in these words: "The moose-deer, common in these parts, is a very goodly creature, some of them twelve feet high, (in height, says another author more particularly, from the toe of the fore-foot to the pitch of the shoulder twelve feet; in its full growth much larger than an ox) with exceedingly fair horns with broad palms, some of them two fathom or twelve feet from the tip of one horn to the other." That is, fourteen inches wider than ours was.

Another thus describes the manner of the Indians hunting this creature: they commonly hunt the moose, which is a kind of deer, in the winter, and run him down sometimes in half, or a whole day, when the ground is covered with snow, which usually lies here four feet deep; the beast, very heavy, sinks every step as he runs, breaking down trees as thick as a man's thigh with his horns; at length they get up with it, and darting their lances, wound it so that the creature runs heavily on, till tired and spent with loss of blood it sinks and falls like a ruined building, making the earth shake under it."

There are several things in which Ireland and the West-Indies partake in common. For as on the coast of New-England and the island Bermudas considerable quantities of ambergris are gathered: so on the western coast of Ireland, along the counties of Sligo, Mayo, Kerry, and the isles of Arran, they frequently meet with large parcels of that precious substance, so highly valued for its perfume. Near Sligo there was found one piece that weighed fifty-two ounces. On the outside it was of a close compact substance, blackish and shining like pitch; but when it was cut, the inside was more porous, and something of a yellowish colour, not so grey, close, and smooth as the cleanest and best sort of amber, but, like it, speckled with whi-

tish grains, and of a most fragrant scent. Many other pieces have been there found.

What sort of substance spermaceti is, and in what part of the whale it is found, physicians and naturalists are not agreed; but it is truly nothing else but part of the oil or liquid fat of this particular sort of whale; which oil, at first when confused and mixed, shows like a whitish liquor of the consistence and colour of whey, but laid by in vessels to settle, its parts by degrees separate; that which is lighter and swims at top, becomes a clear oil, pellucid like water, answering all the uses of common train oil got out of the blubber of other whales; that which subsides, because it is heavier and of a closer consistence, candies together at the bottom, and is what is sold for spermaceti. Of this substance several hundred pounds weight may be procured out of one whale; but the cleansing and curing of it is troublesome, and requires no small art, time, and charge; the fat of the whole body affords it, but that of the head yields the greatest quantity, and purest spermaceti.

[*Phil. Trans.* 1697.]

2. *On the Bones of the Mammoth and other unknown quadrupeds of enormous size dug up in Siberia. By John Philip Breyne, M.D. F.R.S.*

In the Philosophical Transactions, No. 403 and 404, Sir Hans Sloane gave accounts of elephants' teeth found underg-round. In the same year, viz. 1728, Dr. Breyne was busied about the very same matter, especially to prove, that the extraordinary large teeth and bones found under-ground, and dug up in several places of Siberia, by the name of mammoth's, or mammut's, teeth and bones, were,

1. True bones and teeth of some large animals once living, and,
2. That those animals were elephants, by the analogy of the teeth and bones with the known ones of elephants.
3. That they were brought and left there by the universal deluge.

After that, viz. in the year 1730, Dr. Messerschmidt returned to Dantzic from his tour through Siberia, and communicated some curious draughts of a part of a skeleton, viz. of a very large skull, *exsertus et molaris*, with the *os femoris*, belonging to the animal commonly called mammoth, found in Siberia; by which the assertion, that the teeth and bones, called in Russia mammoth's bones,

are the true teeth and bones of elephants, is not only put in a clearer light, but seems demonstrated beyond all doubt.

In 1722, Dr. Messerschimdt found two very large teeth, which he sent to Dr. Breyne. After he had made an accurate and nice examination of them, he found that one is a *dens molaris*, or grinder, a foot broad, half a foot long, and three inches thick, weighing eight pounds and three pennyweights, pretty entire, except that it is broken in two pieces, and the extremities of the roots spoiled. The substance is between that of a bone and stone, except that on the upper part of the outside, some parallel undulated lines appear, which have still preserved the enamel of the tooth.

The other is a piece of a *dens exsertus*, or tusk, eight inches long and three inches thick, or one pound and six ounces weight; in some places not different from ivory, but in others calcined like the common *unicornu fossile*.

What Ysbrand Ides mentions of the mammoth's teeth and bones, is deserving of notice: as also the Journal of Lauren's Lange's Journey to China, and the remarks of Captain John Bernard Muller, in his Present State of Russia. These are the chief authors* who have treated of the mammoth's teeth and bones, as a very remarkable and particular curiosity of Siberia. And what we may select out of them, as matters of fact, are the following particulars.

1. That those teeth and bones are found in Siberia, chiefly in the northern parts, near the rivers Jenizea, Trugau, Mongam-sea, Lena, &c. towards the icy sea; at the time when the ice has broken the banks of those rivers, so that part of the adjacent mountains fall down; and that they are found in such quantity as is sufficient for trade, and to make a monopoly for the Czar.

2. That sometimes skeletons of this kind are found nearly complete.

3. That those teeth and bones are not found always of the same size, but sometimes very large; as *dentes molares*, or grinders, of twenty or twenty four pounds weight, and *dentes exserti*, two of which weighed four hundred pounds; sometimes of a middle size, as those abovementioned, and at other times still smaller.

4. That of those teeth, viz. *dentes exserti*, some are used as ivory to make combs, boxes, &c. Captain Muller says, that in every re-

* Add Gmelin and Pallas. —Orig.

spect it resembles the common ivory, being but a little more brittle, and easily turning yellow by weather or heat.

Out of these quoted remarks, joined to ocular inspection, Dr. Breyne thinks he may advance three things.

1. That those mammoths' teeth and bones are truly natural teeth and bones, belonging to very large living animals: because they have not only the external figures and proportions, but also the internal structure analogous to natural teeth and bones of animals.

2. That those large animals have been elephants, as appears by the figure, structure, and size of the teeth, which accurately agree with the grinders and tusks of elephants, as represented by several writers.

3. That those teeth and bones of elephants were brought thither by a deluge, by waves and winds, and left behind after the waters returned into their reservoirs, and were buried in the earth, even near the tops of high mountains. And because we know nothing of any particular extraordinary deluge in those countries, but of the universal deluge of Noah, it is more than probable, that we ought to refer this strange phenomenon to the said deluge.

It may be noticed, that such teeth and bones are also to be found in several other countries, besides Siberia, as Poland, Germany, Italy, England, Ireland, and many others; but less common than in Siberia, and not so well preserved, but more wasted and calcined, doubtless by the greater warmth of those climates.

Hither also are to be referred the large bones found under-ground, or rather tusks of elephants, known by the names of *ebur, seu unicornu fossile,* which are of the same origin with the mammoth's teeth, but different, as they are better preserved, and have still the natural bony substance, and may serve the workmen as natural ivory, and in some measure the physicians and apothecaries as *ebur, seu unicornu fossile.*

Of the above bones, the head weighed one hundred and thirty pounds and a quarter avoirdupoise weight, or one hundred and fifty-two Russian pounds; its length or greatest height is forty-eight inches; its greatest breadth near the ears twenty-nine inches, five lines; its thickness, from the forehead to the nape of the neck, twenty-two inches, five lines.

One grinder weighs eight pounds nine ounces, or ten pounds Rus-

sian; its greatest length twelve inches; its perpendicular height five inches; its thickness or breadth three inches; it is made up of above twenty transverse lamellæ, a finger thick, perpendicularly erect, lying close to each other, and its root composed of two apophyses.

The tusk, by some improperly called the horn, of the right side, having a two-fold direction by being bent outward and backward, which is peculiar to the male elephant, it being straiter in the female. It is the *ebur fossile* of the shops, and weighs one hundred and thirty-seven pounds, or one hundred and sixty pounds Russian; its length, or the exterior circumference of its back part, was one hundred and thirty-six inches, five lines; the circumference of the root, where it got clear of the socket, was the greatest, being eighteen inches, five lines; the subtended arch, from one extremity to the other, fifty-five inches.

The tusk, answering to the foregoing on the left side, was quite like that on the right, except the contrary direction of its curvature, and its less weight, having lost its point; for it weighed only 128½ lb. or 150 lb. Russian.

The right thigh-bone weighed 21 lb. 6 oz. or 25 lb. Russian; its perpendicular length is 38 inches 5 lines; the greatest breadth of its upper head, or apophysis, 11 inches; its circumference at the middle of the bone about 13 inches.

The bones of this skeleton, with the ribs, vertebræ, and others belonging to it, were found in the side of a sandy stee p hillon the eastern bank of the river Indigirska, which falls into the northern ocean, not far from the mouth of the rivulet Wolockowoi ruzsei. And some of these bones are found not only in these parts, but likewise in the sand hills on the rivers Chatanga, Thomas, Tobol, Irtisch, &c. which are all at a good distance from the sea; though neither elephants, nor chimerical behemoths, have been ever seen in those countries, nor could they live there by reason of the inclemencyof the air. Wherefore the best judges follow the opinion of the learned Dr. Woodward, the Scheuchzers, and others, in taking them for the bones of antediluvian animals, or of such as were conveyed thither in the universal deluge.

[*Phil. Trans.* 1737.]

3. *Observations on the Fossil Bones presented to the Royal Society by his Most Serene Highness the Margrave of Anspach, &c. By John Hunter, Esq. F.R.S.*

The bones which are the subject of the present paper, are to be considered more in the light of incrustations than extraneous fossils, since their external surface has only acquired a covering of crystalized earth, and little or no change has taken place in their internal structure. The earths with which bones are most commonly incrusted, are the calcareous, argillaceous, and siliceous, but principally the calcareous; and this happens in two ways: one, the bones being immersed in water in which this earth is suspended; the other, water passing through masses of this earth, which it dissolves, and afterwards deposits on bones which lie underneath. Bones which are incrusted seems never to undergo this change in the earth, or under the water, where the soft parts were destroyed; while bones that are fossilized become so in the medium in which they were deposited * at the animal's death. The incrusted bones have been previously exposed to the open air; this is evidently the case with the bones at present under consideration, also those of the rock of Gibraltar, and those found in Dalmatia; and from the account given by the Abbé Spalanzani, those of the island of Cerigo are under the same circumstances. They have the characters of exposed bones, and many of them are cracked in a number of places, particularly the cylindrical bones, similar to the effects of long exposure to the sun. This circumstance appears to distinguish them from fossilized bones, and gives us some information respecting their history.

If their numbers had corresponded with what we meet with of recent bones, we might have been led to some opinion of their mode of accumulation; but the quantity exceeds any thing we can form an idea of. In an inquiry into their history three questions naturally arise: did the animals come there and die? or were their bodies brought there, and lay exposed? or were the bones collected from different places? The first of these conjectures appears the most

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* Bones that have been buried with the flesh on, acquire a stain which they never lose; and those which have been long immersed in water, receive a considerable tinge.—Orig.

natural; but yet I am by no means convinced of its being the true one. Bones of this description are found in very different situations, which makes their present state more difficultly accounted for. Those in Germany are found in caves. The coast of Dalmatia is said to be almost wholly formed of them, and we know that this is the case with a large portion of the rock of Gibraltar.

If none were found in caves, but in solid masses covered with marl or lime-stone, it would then give the idea of their having been brought together by some strange cause, as a convulsion in the earth, which threw these materials over them; but this we can hardly form an idea of; or if they had all been found in caves, we should have imagined these caves were places of retreat for such animals, and had been so for some thousands of years; and if the bones were those of carnivorous animals and herbivorous, we might have supposed that the carnivorous had brought in many animals of a smaller size which they caught for food; and this, on the first view, appears to have been the case with those which are the subject of this paper; yet when we consider that the bones are principally of carnivorous animals, we are confined to the supposition of their being only places of retreat. If they had been brought together by any convulsion of the earth, they would have been mixed with the surrounding materials of the mountains, which does not appear to be the case; for though some are found sticking in the sides of the caves incrusted in calcareous matters, this seems to have arisen from their situation in the cave. Such accumulation would have made them coeval with the mountains themselves, which from the recent state of the bones I should very much doubt.

The difference in the state of the bones shows that there was probably a succession of them for a vast series of years; for if we consider the distance of time between the most perfect having been deposited, which we must suppose were the last, and the present time, we must consider it to be many thousand years; and if we calculate how long these must still remain to be as far decayed as some others are, it will require many thousand years, a sufficient time for a vast accumulation: from this mode of reasoning therefore, it would appear that they were not brought here at once in a recent state.

The animal earth, as it is called, at the bottom of these caves, is

supposed to be produced by the rotting of the flesh, which is supposing the animals brought there with the flesh on; but I do conceive, that if the caves had been stuffed with whole animals, the flesh could not have produced a tenth part of the earth; and to account for such a quantity as appears to be the produce of animals, I should suppose it the remains of the dung of animals who inhabited the caves, and the contents of the bowels of those they lived on. This is easily conceived from knowing that there is something similar to it, in a smaller degree, in many caves in this kingdom, which are places of retreat for bats in the winter, and even in the summer, as they only go abroad in the evenings; these caves have their bottoms covered with animal earth, for some feet in depth, in all degrees of decomposition, the lowermost the most pure, and the uppermost but little changed, with all the intermediate degrees; in which caves are formed a vast number of stalactites, which might incrust the bones of those that die there.

The bones in the caves in Germany are so much the object of the curious, that the specimens are dispersed throughout Europe, which prevents a sufficient number coming into the hands of any one person to make him acquainted with the animals to which they belong. From the history and figures given by Esper, it appears that there are the bones of several animals; but what is curious, they all appear to have been carnivorous, which we should not have expected. There are teeth, in number, kind, and mode of setting, exactly similar to the white bear, others more like those of the lion: but the representations of parts, however well executed, are hardly to be trusted to for the nicer characters, and much less so when the parts are mutilated.

The bones sent by the Margrave of Anspach agree with those described and delineated by Esper as belonging to the white bear; how far they are of the same species among themselves, I cannot say, the heads differ in shape from each other; they are, on the whole, much longer for their breadth than in any carnivorous animal I know of; they also differ from the present white bear, which, as far as I have seen, has a common proportional breadth; it is supposed indeed, that the heads of the present white bear differ from each other, but the truth of this assertion I have not seen heads enough of that animal to determine. The heads not only vary in

shape, but also in size, for some of them, when compared with the recent white bear, would seem to have belonged to an animal twice its size, while some of the bones correspond in size with those of the white bear, and others are even smaller*.

There are two *ossa humeri*, rather of a less size than those of the recent white bear; a first vertebra, rather smaller; the teeth also vary considerably in size, yet they are all those of the same tribe; so that the variety among themselves is not less than between them and the recent. In the formation of the head, age makes a considerable difference; the skull of a young dog is much more rounded than an old one, the ridge leading back to the occiput, terminating in the two lateral ones, hardly exists in a young dog; and among the present bones there is the back part of such a head, yet it is larger than the head of the largest mastiff; how far the young white bear may vary from the old, similar to the young dog, I do not know, but it is very probable.

Bones of animals under circumstances so similar, though in different parts of the globe, one would have naturally supposed to consist chiefly of those of one class or order in every place, one principle acting in all places. In Gibraltar they are mostly of the ruminating tribe, of the hare kind, and the bones of birds; yet there are some of a small dog or fox, and also shells. Those in Dalmatia appear to be mostly of the ruminating tribe, yet I saw a part of the os hyoides of a horse; but those from Germany are mostly carnivorous. From these facts we should be inclined to suppose, that their accumulation did not arise from any instinctive mode of living, as the same mode could not suit both carnivorous and herbivorous animals.

In considering animals respecting their situation on the globe, there are many which are peculiar to particular climates, and others that are less confined, as herrings, mackarel, and salmon; others again, which probably move over the whole extent of the sea, as the shark, porpus, and whale tribe; while many shell-fish must be

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* It is to be understood, that the bones of the white bear that I have, belonged to one that had been a show, and had not grown to the full or natural size; and I make allowance for this in my assertion, that the heads of those incrusted appear to belong to an animal twice the size of our white bear.—Orig.

confined to one spot. If the sea had not shifted its situation more than once, and was to leave the land in a very short time, then we could determine what the climate had formerly been by the extraneous fossils of the stationary animals, for those only would be found mixed with those of passage; but if the sea moves from one place to another slowly, then the remains of animals of different climates may be mixed, by those of one climate moving over those of another, dying, and being fossilized; but this I am afraid cannot be made out. By the fossils, we may however have some idea how the bones of the land animals fossilized may be disposed with respect to those of the sea.

If the sea should have occupied any space that never had been dry land prior to the sea's being there, the extraneous fossils can only be those of sea animals; but each part will have its particular kind of those that are stationary mixed with a few of the amphibia, and of sea birds, in those parts that were the skirts of the sea. I shall suppose that when the sea left this place it moved over land where both vegetables and land animals had existed, the bones of which will be fossilized, as also those of the sea animals; and if the sea continued long here, which there is reason to believe, then those mixed extraneous fossils will be covered with those of sea animals. Now if the sea should again move and abandon this situation, then we should find the land and sea fossils above-mentioned disposed in this order; and as we begin to discover extraneous fossils in a contrary direction to their formation, we shall first find a stratum of those of animals peculiar to the sea, which were the last formed, and under it one of vegetables and land animals, which were there before they were covered by the sea, and among them those of the sea, and under this the common earth. Those peculiar to the sea will be in depth in proportion to the time of the sea's residence, and other circumstances, as currents, tides, &c.

From a succession of such shiftings of the situation of the sea we may have a stratum of marine extraneous fossils, one of earth, mixed probably with vegetables and bones of land animals, a stratum of terrestrial extraneous fossils, then one of marine productions; but from the sea carrying its inhabitants along with it, wherever there are those of land animals there will also be a mixture of marine ones; and from the sea commonly remaining thousands of

years in nearly the same situation, we have marine fossils unmixed with any others.

All operations respecting the growth or decomposition of animal and vegetable substances go on more readily on the surface of the earth than in it; the air is most probably the great agent in decomposition and combination, and also a certain degree of heat. Thus the deeper we go into the earth, we find the fewer changes going on; and there is probably a certain depth where no change of any kind can possibly take place. The operation of vegetation will not go on at a certain depth, but at this very depth a decomposition can take place, for the seed dies, and in time decays; but at a still greater depth, the seed retains its life for ages, and when brought near enough to the surface for vegetation, it grows. Something similar to this takes place with respect to extraneous fossils; for though a piece of wood or bone is dead, when so situated as to be fossilized, yet they are sound and free from decomposition, and the depth, joined with the matter in which they are often found, as stone, clay, &c. preserves them from putrefaction, and their dissolution requires thousands of years to complete it; probably they may be under the same circumstances as in a vacuum; the heat in such situations is uniform, probably in common about fifty-two or fifty-three degrees, and in the colder regions they are still longer preserved.

I believe it is generally understood that in extraneous fossils the animal part is destroyed; but I find that this is not the case in any I have met with. Shells, and bones of fish, most probably have the least in quantity, having been longest in that state, otherwise they should have the most; for the harder and more compact the earth, the better is the animal part preserved; which is an argument in proof of their having been the longest in a fossil state. From experiment and observation, the animal part is not allowed to putrefy, it appears only to be dissolved into a kind of mucus; and can be discovered by dissolving the earth in an acid; when a shell is treated in this way, the animal substance is not fibrous or laminated, as in the recent shell, but without tenacity, and can be washed off like wet dust; in some however it has a slight appearance of flakes. In the shark's tooth, or glosso-petra, the enamel is composed of animal substance and calcareous earth, and is nearly in the same quantity

as in the recent; but the central part of the tooth has its animal substance in the state of mucus interspersed in the calcareous matter. In the fossil bones of sea animals, as the vertebræ of the whale, the animal part is in large quantity, and in two states; the one having some tenacity, but the other like wet dust; but in some of the harder bones it is more firm.

In the fossil bones of land animals, and those which inhabit the waters, as the sea-horse, otter, crocodile, and turtle, the animal part is in considerable quantity. In the stags' horns dug up in Great Britain and Ireland, when the earth is dissolved, the animal part is in considerable quantity, and very firm. The same observations apply to the fossil bones of the elephant found in England, Siberia, and other parts of the globe; as also those of the ox kind; but more particularly to their teeth, especially those from the lakes in America, in which the animal part has suffered very little; the inhabitants find little difference in the ivory of such tusks from the recent, but its having a yellow stain; the cold may probably assist in their preservation. The state of preservation will vary according to the substance in which they have been preserved; in peat and clay I think the most; however, there appears in general a species of dissolution; for the animal substance, though tolerably firm, in a heat a little above a hundred degrees becomes a thickish mucus, like dissolved gum, while a portion from the external surface is reduced to the state of wet dust.

In incrusted bones, the quantity of animal substance is very different in different bones. In those from Gibraltar there is very little; it in part retains its tenacity, and is transparent, but the superficial part dissolves into mucus. Those from Dalmatia give similar results when examined in this way. Those from Germany, especially the harder bones and teeth, seem to contain all the animal substance natural to them, they differ however among themselves in this respect. The bones of land animals have their calcareous earth united with the phosphoric acid instead of the aërial, and I believe retain it when fossilized, nearly in proportion to the quantity of animal matter they contain.

The mode by which I judge of this, is by the quantity of effervescence; when fossil bones are put into the muriatic acid it is not nearly so great as when a shell is put into it, but it is more in some,

though not in all, than when a recent bone is treated in this way, and this I think diminishes in proportion to the quantity of animal substance they retain; as a proof of this, those fossil bones which contain a small portion of animal matter, produce in an acid the greatest effervescence when the surface is acted on, and very little when the centre is affected by it; however, this may be accounted for by the parts which have lost their phosphoric acid, and acquired the aërial, being easiest of solution in the marine acid, and therefore dissolved first, and the aërial acid let loose. In some bones of the whale the effervescence is very great; in the Dalmatia and Gibraltar bones it is less; and in those the subject of the present paper it is very little, since they contain by much the largest proportion of animal substance.

[*Phil. Trans.* 1794.]

4. *General History of Fossil Bones.*

It is curions to observe how different an impression the same natural appearances have made on the human mind in different states of its improvement. A phenomenon which, in one age, has excited the greatest terror, has, in another, been an object of calm and deliberate observation; and the things which have at one time led to the most extravagant fiction, have, at another, only served to define the boundaries of knowledge. The same comet which, from the age of Julius Cæsar, had three times spread terror and dismay through the nations of the earth, appeared a fourth time, in the age of Newton, to instruct mankind, and to exemplify the universality of the laws which that great interpreter of nature had discovered. The same fossil remains, which, to St. Augustine or Kircher, seemed to prove the former existence of giants of the human species, were found, by Pallas and Cuvier, to ascertain the nature and character of certain genera and species of quadrupeds which have now entirely disappeared.

From a very early period, indeed, such bones have afforded a measure of the credulity, not of the vulgar only, but of the philosophers. Theophrastus, one of the ancients who had most devoted himself to the study of the nature, believed, as Pliny tells us, that bones were a sort of mineral production that originated and grew in

the earth. St. Augustine says, that he found, on the sea-shore near Utica, a fossil human tooth, which was a hundred times the size of the tooth of any person living. Pliny says, that, by an earthquake in Crete, a part of a mountain was opened, which discovered a skeleton sixteen cubits, or twenty-four feet long, supposed to be that of Orion. At a much later period, Kircher tells us of a skeleton dug up near Rome, which, by an inscription attached to it, was known to be that of Pallas (slain by Turnus), and was higher than the walls of the city. The same author tells us, that another skeleton was found near Palermo, that must have belonged to a man four hundred feet high, and who therefore could be no other than one of the Cyclops, most probably Polyphemus himself. The same author has given the measures of several other colossal men, and exhibits them in an engraving adapted to a scale, and placed in order, from the common size up to that of the giant last mentioned.

The belief in men of such enormous stature, no doubt arose from the appearance of bones of elephants, and other large animals found in the earth. When we consider, that the credulity and misinterpretation that are here so striking, are not the errors of the weak and illiterate, but of men of talents and learning,—the best instructed by reading, conversation, and foreign travel, of any in the ages in which they lived,—we cannot help being struck with the difference between the criterion of truth as received in those ages and in the present time.

We are persuaded that the reason of this diversity, which is perhaps as remarkable as any circumstance whatever in the history of human knowledge, is to be found in the progress of natural and experimental philosophy, which, by generalizing particular facts, has given a force and extent to the conclusions from experience, which they did not possess at any former period.

It is a well-known fact, that, on the continent of Europe there are few countries where bones of large animals, having an obvious affinity to those of the elephant, have not been found, buried in the earth; a circumstance no doubt the more wonderful, that no such animals exist now in these countries.

Germany has afforded a great number of such instances. An entire skeleton of an elephant, found very deep under the surface, near Tonna, in Thuringia, and described in the Philosophical Trans-

actions *, was the subject of much speculation. Remains of the same kind, found by Marsigli in Transylvania, are described in his History of the Danube, and supposed to be remains of elephants, which the Emperor Trajan had carried with him in his expedition against the Dacians.

In the beginning of the last century, the Duke of Wurtemberg by following some indications which had accidentally presented themselves, found no less than sixty tusks of elephants, some of them ten feet long, together with many teeth of other animals quite unknown in our climates.

Italy has furnished a great many instances of the same kind. In the upper vale of the Arno, the humerus of an elephant was found, with oyster shells adhering to it; from which it is evident, that it must at one time have been at the bottom of the sea. The country about Verona may be considered as a great natural cabinet, in which is preserved a vast number of extraneous bodies, both from the sea and from the land †. Alberto Fortis has described some bones found near that place, of a very remarkable size. There was one tusk about thirty inches in circumference at the root, and from twelve or thirteen feet in length.

He says, that the only tusks of living elephants that he has heard of, that approach near to the above dimensions, are two which belonged to the Emperor Aurelian, each of them ten feet in length. It is at present reckoned a large tusk that measures from seven to eight feet in length, and ten or twelve inches in circumference.

Such facts as the union of sea-shells with bones of this kind, were no doubt what suggested to Leibnitz the idea which he has thrown out in his Protogea, that they must have belonged to a marine animal that had something of the elephant form. The osteology, however, of these animals, and particularly of their feet, does not admit of the supposition that they were inhabitants of the sea.

Though it be true, that some of the fossil bones found in Italy and in other countries, have the appearance of having been under water, yet there are others in a situation so perfectly undisturbed, that there is no room to suspect their submersion in the sea. An entire skeleton, for example, was dug up near Arezzo, in 1663, just

* Vol. xxiv. p. 234. † Mem. de Fortis, vol. ii. p. 284.

in the state wherein the animal might be supposed to have died; and must, probably, be that of an elephant which had sunk, and been swallowed up in the marshes of that plain. The remains found, in the instances here enumerated, have either belonged entirely, or chiefly, to the elephant. In others, the bones have belonged to a variety of animals; to the rhinoceros, for example; to the hyæna; to an animal like the horse; to deer, oxen, hares, and also to some of the small carnivorous quadrupeds.

A general fact with regard to them is, that they are found in the alluvial and unconsolidated earth, generally in the valleys of rivers, and not far from their banks. There is accordingly hardly any of the great rivers on the continent, where fossil bones have not been discovered. The basins of the Danube, the Rhine, the Elbe, the Oder, and the Vistula, are all quoted in the Memoir of Cuvier. It is not, however, only on the continent, nor in the valleys of the greatest rivers, that such bones are found;—they are found also in islands.

Sir Hans Sloane had a tusk of an elephant, dug up in London, from a gravel pit twelve feet deep, at the end of Gray's-inn-lane. He possessed also another found in a stratum of blue clay, in Northamptonshire. Cuvier mentions, that he has himself part of the bones of the fore foot of an elephant found at Kew, eighteen feet under the ground.

Bones of the same kind have been found in the Isle of Sheppey, at the mouth of the Thames, in Salisbury Plain, and in Wales. We have to add to those instances, that grinders of the elephant, and vertebræ of the hippopotamus, have been found, together with the bones of several smaller animals, in some fields where they were digging clay for bricks, on the banks of the Thames, not far from Brentford. There seems, indeed, to be at that place a very considerable repository of fossil bones.

Even Iceland has contributed its share to these wonders; and the jaw of an elephant, sent from thence, is mentioned by Thomas Bartholinus as having been placed in the collection of the University of Copenhagen. A cranium and a tooth are said by Torfæus to have been brought from the same island. When we meet with such bones in an island near the polar circle, we need not be surprised to find them in the islands of the Mediterranean. What is remarkable,

however, is, that they are found, not only in the greater islands, such as Sicily and Cyprus, but in the smaller, such as Santorini, and even Cerigo; in which last, as Fortis observes, an elephant would hardly find food for a single week. These places, therefore, when they were inhabited by such large animals as the elephant or the rhinoceros, must have made part of a great wooded continent, in which Iceland and Cerigo were alike included.

It is, however, in Siberia that the greatest quantity of the remains we are now considering have been found. The quantity of fossil ivory discovered on the banks of the great rivers of that country, had been long an object of traffic, and had excited the wonder of the Ostiaks and Tonguses before they drew the attention of the philosophers of Europe.

They were known by the name of mammoth's bones, and have been carefully examined and described both by Pallas and others. There is, indeed, no river in the north of Asia, from the Tanais to the extremity of the old continent, in the bed and on the banks of which are not to be found the bones of elephants and of other large animals, unknown in these countries. While the river has its course among the mountains, the bones are not found; but they never fail to be met with, when it leaves the high ground, and makes its way through the plains. They are often found in confused masses: in other instances, they are quite regular; and, in the high banks of the rivers, appear in the strata of earth, at different heights above the surface of the water.

One of the most singular facts of this kind, is that of the rhinoceros, found in the frozen earth on the banks of one of the branches of the Lena, the skin and part of the flesh being preserved. Pallas had this most extraordinary specimen dried in an oven, and deposited in the museum of the academy of St. Petersburg. One of the feet was very entire, and was covered with hair from one to three lines in length. Pallas observes, that he had never heard of so much hair being found on the whole body of a living rhinoceros, as had been found on the foot of this; and from thence, he suggests the probability that the animal was a native, not of the torrid zone, but of the middle of Asia; as it is known that the rhinoceros, in the northern parts of India, has more hair scattered over his body than in the south of Africa.

This last fact has farther light thrown on it, by a very recent discovery made in the most northern part of Siberia, of which Cuvier and La Cepede have given a joint report in the 10th volume of the Annales. It was mentioned, they observe, in the English Journals, that, in 1799, a Tonguse discovered, from a distance, a singular mass, in a heap of ice, on the sea shore, but was unable to approach it. In the next summer he saw it again, and observed that it was somewhat detached from the ice. He saw it, however, only from a distance.

In 1801, one of the horns was completely disengaged; but, in 1802, the summer was so bad, that the ice again covered this unknown body. In 1803, the ice melted, and the mass fell, by its own weight, on a bank of mud. In 1804, they cut off its horns, and a kind of drawing was made, from which it appears that this animal differed little from the mammoth.

Granting, therefore, say the reporters, that the animal thus singularly preserved, is the mammoth,—which, however, they do not absolutely affirm,—the fact becomes particularly valuable, from what is said concerning the hair.

Mr. Adam, who visited the spot, said that the animal was covered with two kinds of hair; the one finer and shorter, the other coarser and longer. There was even a kind of mane on the neck; and Mr. Adam found thirty-six pounds weight of hair left by the beasts of prey that had devoured the flesh.

This species of elephant differed, therefore, from that of India, and was probably adapted to a cold climate, by the covering which nature had provided for it. This agrees with the circumstance just remarked concerning the rhinoceros of the Lena.

The preservation of the flesh and muscles leads, in the opinion of the French naturalists, to a third conclusion, that the species was destroyed by some sudden catastrophe; those individuals that were near to the Frozen Ocean having had their flesh preserved by the ice. Whatever opinion we form as to the mode of their destruction, we can hardly doubt that species of the elephant and rhinoceros have existed, in some former age of the world, accommodated to all climates, and capable of living in the frozen regions of the north. Some of them also may have perished in consequence of a sudden revolution; but this cannot have been the general fact; because, as

we have already remarked, on the authority of Patrin, the remains which appear in the banks of the rivers are in the strata of earth at very different heights; so that they must have been laid in their present situation at different periods of time.

The animals, therefore, seem to have been bred, and to have lived for a long succession of generations, in the countries where their bones are deposited. They are species of the elephant and rhinoceros that are now entirely extinct, and that were accommodated to the cold climates of the north.

A very remarkable fact relating to these bones, is mentioned in the account of Billings's Voyage. In the Icy Sea between the mouths of the Lena and Indigerka, are three islands, of which a Russian engineer was employed to make a chart in 1775. Of the largest and nearest to the coast, which was about thirty-six leagues long, with a breadth from five to twenty; he reported, that the whole, except three or four hills which were of rock, was a mixture of sand and ice; so that, when it thawed, large masses on the shore tumbled down, and never failed to discover the bones and teeth of the mammoth in great abundance. The island seemed as if it had been formed of the bones of that animal, together with the heads and horns of buffaloes, and a few horns of the rhinoceros. The second island, about five leagues farther from the coast, contained also bones of the same nature; but the third, which was the farthest off, contained none at all.

The great Siberian rivers seem, therefore, to have carried down, for ages, the bones of elephants and rhinoceroses, in the same way almost as other rivers carry down trees; and to have formed them into islands with the assistance of sand and ice. This is a mode of forming land, which, without the experience of it, we do not think that it could have entered into the thoughts of any geologist to imagine.

All this gives an astonishing measure to the quantity of fossil bones that the Siberian rivers carry down. The accurate observation and diligent research of Cuvier, supported by his extraordinary skill in comparative anatomy, have led him to some general conclusions concerning these animal remains, that are of importance in the natural history of the earth.

The bones of the mammoth have a considerable resemblance to

those of the present elephants of India; not so close, however, but that they differ more than those of the horse and the ass; so that they cannot be supposed to belong to animals of the same species. This is true also of the elephants' bones found in Europe; so that the fossil elephant is of a species different from any that is now known.

This conclusion might perhaps have less probability, if there were only one fossil, to be compared with one living species. But a comparison of the osteology of the fossil with that of the living rhinoceros shows, that they also are of different species, and that the diversity is even more remarkable, than in the former instance.

An animal has also been found in a fossil state, that belongs to the genus of the tapir, but of a species different from any now living. This animal, among the living tribes of the present world, is confined to the new continent. In former ages its residence seems to have been exclusively in the old; for among the fossil animals of America, the tapir has never been discovered. The bones of these animals (which all belong to the order of the pachydermata, that is to say, of thick-skinned quadrupeds, having more than two toes to the foot, and incisive teeth in both jaws), though entire skeletons, have sometimes been found alone; are more frequently mixed with the bones of other quadrupeds,—the ox, the buffalo, the horse, the antelope; and to these are sometimes added, shells, and the bones of marine animals.

The beds which cover those fossil remains, are not always of great thickness; they are almost never of a stony nature, but consist of alluvial and unconsolidated earth. The bones themselves are rarely petrified, and have no appearance of being rolled or carried by water from one region of the globe to another.

The abundance of them in so many climates is in itself a proof, without any other circumstance, that they were not transported, by a sudden inundation, from one place of the earth to another; for they could not, in that way, have been so generally diffused. On the same principle, we conclude, that these bones have not been buried by the hands of men. If the only instances in which they occurred were in countries that had been conquered by the arms of the Macedonians, the Carthagenians, and the Romans; and if the bones found were those of the elephant only, there might be some

pretence for supposing them to be the bones of animals of the last-mentioned species which had perished in war. But when the number of individuals is so great, when the region to which they extend is so vast, and the bones of other animals so frequently intermixed, we must acknowledge, that they have not been the victims of the restlessnes and ambition of the human race. Indeed, they probably belong to a period when man's dominion over the earth was weak and partial; when the human race, perhaps, was confined to some favourite spot in the valley of the Nile, or in the plains of Shinnar; and when the elephant, from his sagacity and strength, remained master of the earth.

The facts also that have been stated, lead us to reject Buffon's explanation, founded on the gradual refrigeration of our globe. The rhinoceros of the Lena, and the mammoth whose carcase was preserved in the ice, must have lived and died in a cold climate; so that, as soon as the warmth of life was extinguished, the antiseptic power of cold prevented the approach of corruption. The skilful and indefatigable naturalist whose discoveries we are now considering, beside all this, has clearly proved, that the fossil pachydermata contain six different species that are now extinct, though belonging to genera which still exist;—one species of rhinoceros, two of the hippopotamus, two of the tapir, and one of the elephant. All the genera to which these species belong, are perfect strangers in the climates where their bones are found. Three of them belong to the old continent, and one of them only to the new.

These, however, are not the only wonders which the fossil remains of this order of quadrupeds have discovered. The bones from the Ohio have been long known, and were the first which convinced naturalists that certain species had become entirely extinct. The great animal to which these bones must have belonged, was for a long time confounded with the mammoth of Siberia; and though the teeth were admitted to be of a structure quite different, the name of mammoth's bones was very improperly applied to them, both in England and America. The teeth are studded with large tubercles, instead of being composed of alternate layers of bone and enamel, as in the case of the elephant and most graminivorous quadrupeds. The animal must, nevertheless, have had a great affinity to the elephant; yet, on account of its teeth, Cuvier

refers it to a different genus, to which, because of the tubercles just mentioned, he gives the name of mastodonton. A skeleton of this animal was found by Mr. Peale, of Philadelphia, on the banks of Hudson's River, in the state of New York, and is now preserved in his museum. Another, nearly as perfect, was brought to London by his son, Mr. Rembrandt Peale, and was exhibited a few years ago in that metropolis. These skeletons are so complete, that the osteology of the animal may be considered as perfectly known. What rendered this discovery peculiarly interesting was, that in the midst of the bones, there was a mass of small branches, grass and leaves, half bruised, among which they thought they could discover a species of reed at present common in Virginia; the whole appearing as if it had been enveloped in a sack, which they conceived to be the stomach of the animal. Hitherto, it is only in North America that the bones of this animal have been found. Similar bones have been discovered in Peru and in Terra Firma; but they are thought by Cuvier to belong to another species of the same genus.

The general conclusions are, that the great Mastodonton, or animal of the Ohio, was in many respects similar to the elephant, not surpassing it greatly in size, and being probably furnished with a proboscis; that the structure of its grinders refer it nevertheless to a different genus; that it probably fed, like the hippopotamus and the bear, on the roots and tougher parts of vegetables; and that though, on this account, it must have frequented marshy ground, it was not made for swimming, or living in the water, and was truly a land animal; that its bones are most common in North America, and that they are fresher and better preserved than any other fossil bones. Further enquiry has enabled Cuvier to reckon, in all, five different species of the mastodonton, some of which have been found on the Old Continent. One species was found by Humboldt in the kingdom of Quito, at the height of twelve hundred toises. This, we believe, is the greatest height at which the fossil bones of quadrupeds have ever been discovered. Thus we have five species, constituting an entire genus, to be added to the six formerly enumerated; making, in all, eleven species, which have entirely disappeared from among the living inhabitants of the earth.

We have spoken, hitherto, only of those animal remains which occur in the loose and unconsolidated earth. The remains of land

animals, however, and even of quadrupeds, have been sometimes found included in stone, of a slaty and calcareous nature. Of this, the plaster quarries near Paris have afforded a remarkable example, and one that occurred fortunately in a situation where there were many skilful and accurate observers. In the third volume of the Annales, Cuvier gives an account of bones which he had found included between the strata of gypsum, in the plaster quarries near Paris, of which, after a very ample detail of the head, the various parts of which he had been enabled perfectly to replace, he concludes, that no well informed naturalist would deny that these bones had belonged to a herbivorous animal, of the order of Pachydamata, and of a genus between the tapir and the rhinoceros. As little could he deny, says he, that no such animal has yet been discovered among the living tribes on the surface of the earth. He gives to this genus the name of Palæotherium, expressive of its great antiquity.

Farther research into the remains, of which the plaster quarries about Paris contain so many specimens, enabled him to discover another genus similar to the former, but without canine teeth, which he has distinguished by a term indicating this inoffensive structure, Anoplotherium. In each of these genera he distinguished several species, as the Magnum, Medium, Minus, and Commune.

In a Memoir subsequent to those which are considered above, inserted in the 12th vol. of the Annales, Cuvier gives an account of two entire skeletons which he had completed with infinite labour, one of the Anoplotherium commune, and the other of the Palæotherium medium. They were, as has been said, something between the hog and the tapir, but of great size; the Anoplotherium about twelve feet long, measuring to the extremity of the tail.

A reflexion with which he concludes his second Memoir on this subject, is highly deserving of attention *. It must seem strange, he observes, that in a country as extensive as that which our quarries occupy, more than twenty leagues from east to west, there are hardly any animal remains, but of one single family. It can hardly be doubted, that the proportion of bones of any species has some relation to the numbers of that species when alive. This, therefore, indicates a condition of the animal world, corresponding very little

* Annales du M. tom. 3, p. 386.

to what we have now before us. In the present state of the globe the countries which make a part of the two great continents are inhabited by animals of all the different families, each according to its latitude, and the quality of the soil. This, however, is not the case with large islands; and the condition of New Holland, in particular, may throw some light on the state of the country inhabited by the animals in our quarries.

Five-sixths of all the quadrupeds of New Holland belong to one and the same family,—that of the animals of the Opossum kind. The six genera of this family, the Dasyurus, the Phalangist, the Kangaroo, &c. are all very near one another, and have nothing analagous to them in the rest of the world, except the Opossum of South America.

The number of species comprehended in these six genera, amounts at least to forty; and there are not in the whole country above eight or ten species not belonging to them, namely, a wild-dog, two rats, and several species of bat. Here then we have a country, of considerable extent, which, at the present day, in the proportion of the families of existing quadrupeds, offers something very similar to what must have taken place among the fossil animals of our quarries, where we find at least eight that are pachydermous for one that is carnivorous. This consideration must evidently be of weight, if we are to form any conjecture concerning the state of the earth's surface, at the time when it was inhabited by these extinct species.

Besides the Memoires in which Cuvier has described the Pachydermata, he treats, in another, of those carnivorous animals of which the remains are preserved in a fossil state *. The caverns of Germany, found in a great tract of mountainous country, have been long celebrated for the multitude of animal remains which they contain. The mountains in which these caves are found, are all calcareous and connected with one another. Beginning with the Hartz, they separate the valley of the Elbe from that of the Weser, and proceeding eastward, from those of the Rhine and the Danube, till, turning the sources of the Elbe, they go on, to divide the valleys of the Oder, and the Vistula from the plains of Hungary, or the great basin of the Danube. The extent of this chain is more than two hundred leagues.

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* Vol. 7, p. 301.

At one extremity of this long line are Beauman's Cave and Scharfel's in the Hartz, described in the Protogea of Leibnitz. At the other extremity are the caves in Hungary which also contain bones. and which have been known from immemorial time. Between these two extremes, are the caves in Franconia near Bayreuth, and particularly the cave of Gaylenreuth, which of all others is the richest in fossil remains. These caverns are of great extent; they are lined with stalactitical concretions; and in these concretions, near the bottom, and on the floor, are contained a vast number of bones, The bones in them all, are nearly in the same state; detached, shattered, broken, but never rolled; a little lighter and less solid than recent bones, yet in their animal state very little decomposed, containing much gelatinous matter, and not at all petrified.

What is most singular is, that in all these caverns, over a distance of more than two hundred leagues, the bones are the same. Three-fourths of them nearly belongs to two species of bears which no longer exist. About half the remainder belong to a species of hyæna; some few belong to the tyger or the lion; others to the wolf or dog, the fox, the polecat, or to some species nearly allied to them. The species so common in the soil and alluvial ground, as already described, viz. elephants, rhinoceroses, horses, buffaloes, tapirs—are never found here; neither any of the Palæotheria, such as occur in the stony beds abont Paris. So also, conversely, none of the bones found in these caverns are ever discovered in either of the other situations, except those of the hyæna, which are sometimes found in the loose earth. It is also of consequence to observe, that the caves never contain the bones of any marine animals whatever, nor any thing that marks the presence of the sea.

The earth which serves as the *envelope* of the bones, was analyzed by M. Laugier, assistant chemist in the Museum, and was found to contain 21 per cent. of the phosphate of lime, the characteristic of bone. There were 32 per cent. of lime and magnesia combined with carbonic acid; and 24 of the carbonic acid itself. The comparison of the bones with those of living animals has been made with a degree of care, accuracy, and laborious examination, that can hardly be exceeded.

The bones of the carnivorous animals, deposited over this extensive chain, are on a level higher than that at which the bones of the ele-

phant and the other Pachydermata are found, with the exception of that which Humboldt brought from the height of 1200 toises.

There appears, however, to be no distinct marks, by which the order of the two, in respect of time, can be compared with one another. Cuvier seems inclined to think the era of the carnivorous animals later than that to which the bones of the mammoth are to be referred. A very long period, however, and not a mere point of time, must have been required for the accumulation of these bones.

It cannot be doubted, that the animals to which they belonged, lived and died in the caverns where their bones remain. There is no appearance of any sudden catastrophe, like the waters of the ocean, arising and pursuing the animals into caverns, where they at last perished.

But carnivorous animals are solitary, both from inclination and necessity; and instinct would in vain collect those individuals, whom the difficulty of procuring subsistence must soon force to a distance from one another. Each cavern in this extensive chain was therefore the den of a single despot, who sallied forth, as his ancestors had done, to prey on the defenceless inhabitants of those woods, which in later times, after men had become masters of the world, were known by the name of the Hircynian forest. What a length of time must have been required to pave these vast caverns with the bones of their solitary masters, in such quantities as still to astonish the Naturalist, after supplying the apothecaries of Germany from the days of Paracelsus to the presnt time! Indeed, it is a striking mark of the vicissitudes to which the earth and all its inhabitants are subject, that the bones of animals, of which the very race is extinct, and which fed many ages ago on species that are now unknown, should be devoured, in their turn, by the individuals of the human race

The extinct genera and species, of which we have now seen so many examples, belonged to two of the great families of the animal kingdom, the Carnivora and Pachydermata. Among the ruminating animals, a similar loss has not been observed. A memoir of Cuvier, inserted in the 12th volume* of the Annales, contains an account of the principal facts that have been observed concerning these last, particularly the deer, the ox, and the buffalo; of all which, fossil

* p. 333.

remains are frequently discovered. It is remarked, however, that this numerous family presents peculiar difficulties, when its remains are found in a fossil state. For, though the order of ruminating animals is distinguished, by strong and well-marked characters, from every other order, the genera and species are not easily distinguished from one another. This is so much the case, that naturalists, for making out these distinctions, have been obliged to have recourse to the horns, which being entirely exterior, and varying in the same species, both in form and in size, according to the sex, the age, and the climate, cannot fail to be subject to considerable uncertainty. The conclusions, therefore, concerning the identity or the diversity of the genera and species of such animals, can hardly be drawn with the same confidence as in the preceding instances. Admitting this to be true, and looking rather to what is probable, than to what is certain, our author concludes, from a very careful examination, that the remains of ruminating quadrupeds, whether found in the loose earth, or in the fissures of rocks combined with stalactitical concretions, do not differ essentially from the bones of animals now living, and inhabiting the same countries where these remains are found. To this rule, some animals of the deer kind, and especially the fossil Elk of Ireland, form the only exceptions that are known. This is the more remarkable, that the bones of these animals are found along with those of the elephant and the other Pachydermata. In the bones of the horse, as well as in those of the ruminating animals, an accurate resemblance between the fossil and the living species is observed.

The fossil elk of Ireland is the most celebrated of the ruminating animals found in a fossil state, and is that which naturalists are the most unanimous in considering as an unknown species. The horns of this animal are found in Ireland, not, properly speaking, in the bogs, but in the gravel or alluvial earth, which usually forms the base on which the peat-moss rests. The horns are of an extraordinary size; and Cuvier has shown, that they are neither those of the elk nor the rein-deer. The horns of the largest elks, now living, are not above half the size of the fossil horns of Ireland. The results, deduced from a long and accurate comparison, are, that the Irish elk, the deer of Scania, and the great buffalo of Siberia, are unknown animals; but that the other fossil bones of this order, are

undistinguishable from those of the common deer, the roe, the urus, the ox, the buffalo, &c.

The difficulty of accounting for the loss of the species belonging to one family, and the preservation of those belonging to another, are nearly alike; and we cannot hope to understand the one, without having an explanation of the other. Further examination may throw more light on a subject, where, though much has lately been discovered, a great deal no doubt remains to be known.

We have thus offered an abstract of what we conceive to be among the most curious and valuable documents concerning the antient inhabitants of our globe. It is curious to remark, that the principal loss which the lapse of time has produced, so far as we are acquainted with the history of animals, has fallen upon one particular order. There are six genera of Pachydermata now existing; namely, the elephant, the tapir, the hog, the hippopotamus, the daman, and the rhinoceros; and there are three genera, the palæotherium, anoplotherium, and mastodonton, which are lost, besides many species.

The opinion entertained by Cuvier concerning the extinction of these animals, such of them at least as are found in the soil or the alluvial earth, is, that it has been produced by water, or by some sudden inundation that overwhelmed the land to a certain height. There is, indeed, no appearance of the bones having been carried or transported by water; and there is no reason to suspect that the catastrophe arose from a wave or current having such force as to carry every thing along with it. If a deluge were the cause, it must have been a simple submersion of the land under the water, without any thing like that sudden violence which some geologists have imagined. Whether this submersion arose from the rising up of the water, or the sinking down of the land, is not likely to be ascertained from the phænomena of the animal kingdom; and on this subject, the facts, and perhaps, still more the theories of geologists, will incline them to form different opinions. Some perhaps may think, that a sudden catastrophe is not a supposition necessary for the explanation of these appearances. The fossil remains in some countries, particularly in Siberia, where they seem to form the ground-work of entire islands, are too great to owe their origin to the animals existing, at any one instant, on the surface of the globe. The accumulation of ages; the collecting together of the remains which a

long series of years had consigned to the earth, could alone enable the Lena, or the Indegirka to construct those sepulchral monuments which are described above. The common course of nature, therefore, may be sufficient to explain the existence of these animal remains: and the entire loss of certain species may perhaps have arisen from the extension and severity of man's dominion over the earth. The preservation of the Ruminant, and the extinction of so many of the Pachydermous animals, may also, in some measure, be explained by the greater numbers of the former, their wider diffusion, and their greater activity. This much at least may be considered as certain, that the explanation of these fossil bones is to be derived, either from a submersion of the continents under water, quietly and without agitation, or from the accidents which occur in the ordinary course of nature. All other hypotheses seem to be excluded; and this exclusion is no inconsiderable step towards the final solution of the problem.

[*Edin. Rev.—Memoire sur les Elephans Vivans et Fossiles, Mem. sur le grand Mastodonte, &c. Resumé general de l'Histoire des Ossemens Fossils, &c.*

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5. *Petrifactions of the Suburbs of Paris.*

THE Metropolis of France is situated in the midst of a country, which, for one of horizontal or secondary stratification, is among the most remarkable that has ever been described. Great bodies of rock, containing thousands of marine *exuviæ*, alternate regularly with other rocks, in which the shells of fresh-water fish lye similarly imbedded. The bones of land animals, of which not only the species, but even the genera are unknown, occupy entire districts; and other bones, belonging to animals of vast size, and to which we find none analogous, except in very distant countries, are scattered through the beds nearer to the surface. The characters also of a great torrent from the south-east, are impressed on the forms of the hills, and the direction of the principal ridges. All those circumstances unite in forming a country well calculated to instruct us concerning the latter revolutions of the earth's surface.

Two very eminent naturalists, Cuvier and Brongniart, the one

known by his valuable productions in various departments of physical science, and the other by his excellent system of Mineralogy, have undertaken the survey of this tract, and have given an account of their observations in an interesting work, of which we shall lay before our readers the following abstract.

The boundaries of the territory which is here called the country round Paris, are not fixed by arbitrary rules, but by lines which Nature herself has traced out on the surface of the earth.

The valley of the Seine is separated, for a considerable distance from that of the Loire, by an elevated ground of great extent, usually known by the name of Beauce, which stretches from north-west to south-east for more than forty leagues: and from the line of partition of this tract, the rivers descend on the north to the Seine, and on the south to the Loire. The surface of this ridge is formed of sand, which covers all the beds of which the interior consists. From the two extremities of it, or from about the Mauldre on the west, and Nemours on the east, run off two portions of a chalk country, which extend to a great distance in all directions, forming the whole of Upper Normandy, Picardy, and Champagne. The inner boundary of this great belt passes through Montereau, Sézanne, Epernay, on the east; and on the west through Montfort, Mantes, Gisors and Chaumont, to Compiégne; and forms, with the sandy ridge just described, the natural boundary of the district to which the following observations extend.

The whole of the tract comprehended within the limits now described, consists of regular beds of rock or of earth, succeeding one another every where in the same order, from the chalk, which is the lowest, to the sand, which is the uppermost of all. Those successive formations convey the idea of so many deposits made in the bottom of a great gulph, the sides of which were originally of chalk *.

The lowest rock, or that which is inferior to all the rest, is the chalk; and above this are ten others in the order here exhibited.

1. Formation of chalk.
2. — of plastic clay.

* This is certainly inaccurate; the chalk itself is one of the deposites, and is only the first or oldest of the series.

3. Formation of coarse limestone.
4. — silicious limestone.
5. — gypsum, containing bones and fresh-water productions
6. — marl of marine origin.
7. — sandstone without shells.
8. — grit, or sandstone of marine origin.
9. — buhr, or milstone formation without shells.
10. — marl and buhr stratum, containing fresh-water shells.
11. — travelled earth, containing rounded pebbles, pudding stones, argillaceous marl, and peat-moss.

On this enumeration, the authors of the essay remark, that they have used the term formation, adopted by the school of Freyberg, to denote a collection of beds of the same or of different nature, but all formed at the same period. "The greatest part of these 'formations are unknown to the geologists of the celebrated school 'just mentioned, at least we have not besn able to recognize any of 'them in the works which they have published, and which we have 'had occasion to consult. Nevertheless, as it is very possible that 'those different formations exist in other places, it appeared to us 'of consequence to give them such precise denominations, as may 'furnish geologists with the means of recognizing them elsewhere.'

The essay goes on to describe the chalk formation.—It consists of horizontal courses, often indistinctly marked, and never subdivided into thin layers. It contains flints unconnected with one another, but disposed in beds, and adhering to the chalk. It is known, however, that in a great part of Champagne the chalk contains no flints.

This formation is particularly characterized by the fossils or organic remains which it contains, different not only in the species, but often in the genus, from those found in the limestone above.

Though the authors of the essay remark, that all the fossils in the chalk have not yet been enumerated and described, they give us the names of 22 species, not one of which is to be found in the limestone †; the most remarkable of these, and one which they

† It is remarkable that the characters of the chalk about Paris seem to agree perfectly with those of the mountains of St. Peter at Maestricht. The same kind of Belemnite is found on both.

consider as peculiarly characteristic of the chalk formation, is the Belemnite.

In all the chalk about Paris, a skilful naturalist quoted in the essay, M. de France, observes, that no univalve with a simple and regular spiral, such as the Cerite, &c. has never been found; and this is the more remarkable, that such shells are discovered in abundance, a few yards higher up, in the coarse limestone of the third formation. It is certain, however, that this rule does not hold with respect to the chalk of other countries.

2. Almost the whole surface of the chalk is covered with a bed of plastic clay, unctuous and tenacious, very refractory, and containing some silicious but no calcareous matter. It varies in its colour, and in many of its properties, as it also does in its thickness, which in some places is seventeen yards, and in others not more than two or three inches. If there are any organic remains in this clay, they are extremely rare,—and in the few cases where they have been found, seem to have been introduced by accident.

3. The coarse limestone comes next.—It does not, however, always cover the clay immediately, but is ofen separated from it by a bed of sand more or less thick; and it is doubtful whether this sand is to be considered as belonging to the clay or the limestone formation. The latter is composed of alternat layers of coarse limestone, argillaceous marl, clay in thin beds, and lastly calcareous marl; and these always occur in the same order. Some of them are occasionally wanting; but that which is inferior in one district never becomes higher in another. This constancy of their order has been observed in places twelve myriameters, (about 74 English miles,) distant from one another. The means of ascertaining this curious and important fact, was afforded by the fossils contained in the different beds, those belonging to each being sufficiently characterized to ascertain the identify of the stratum in which they were included.

Fifty of the most remarkable of the fossils found in these beds, are enumerated and named in the essay: This, however, is only a small part of the whole; upwards of 600 species having been collected and described by the two able naturalists, MM. de France, and de la Mark.

4. The fourth formation is a silicious limestone, not lying above

the former, nor below it; but in a situation, geologically speaking, level with it, or side by side, and immediately above the plastic clay. It is formed of distinct courses of a calcareous stone, penetrated with silex in all directions. It is often cavernous; and it seems that the silex, in penetrating into the cavities, has covered their sides, in some instances, with mammellated stalactites variously coloured, and in others with short quartz chrystals, very pure and transparent. This formation has never been observed till now, though it exists over so considerable an extent of country. It has this distinctive character, that it contains no organic remains of any kind, either belonging to salt or fresh water.

In this formation is found one species of the rock called a buhr, used for millstones, which seems to be the silicious skeleton of a limestone. The silex having been deprived of the calcareous part, by the operation of some unknown cause, remains now a porous mass, very hard, and containing in its cavities an argillaceous marl, which has no traces of stratification. These millstones, however, must not be confounded with those which will be described afterwards, in the 8th article of this enumeration. The country about Fontainbleau belongs to this species of limestone.

5. & 6. The formations of gypsum and marl come next in order. The gypsum lies immediately on the limestone described above. The formation is not, however, entirely gypseous, but consists of alternate beds of that substance, and of argillacious and calcareous marls. These beds observe the same order of superposition as far as they have been examined. In the beds of this formation, are constantly found the skeletons and scattered bones of birds and of unknown quadrupeds, as also, though but rarely, shells belonging to fresh-water fish; so that it would appear that the gypsum of Montmartre, and of the other plaster quarries about Paris, has been deposited and chrystalized in fresh-water lakes.

In the higher gypseous beds are also contained, the skeletons of the great animals, which Cuvier has described with so much industry and skill. These consist of five different species of the Paleotherium, as many of the Anoplotherium, a Pachyderm of the hog kind, the Canis Parisiensis, the Didelphis Parisiensis, or the Parisian Opossum,—besides three or four unknown species of birds, a tortoise, a crocodile, and some fishes. The upper strata of marl contain remains of the palm tree and of fishes, together with

shells belonging to fresh water. A great number of other fossil remains are found in marly strata of marine formation, that lie above those just mentioned. These amount in all to twenty-six species.

A formation thus curious and enigmatical is conceived by some writers, and particularly a writer in the Edinburgh Review, in his account of M. Cuvier's description, to amount to a confirmation that the gypseous strata in the neigbourhood of Paris, cannot be referred to any of the formations described by Werner. The reasons assigned are, that this gypsum covers the shell limestone, instead of being covered by it; that it is not fibrous; and that it does not alternate with the coarse sandstone, as the second gypseous formation of Werner is supposed to do. This opinion, however, has been since successfully combated by Professor Jameson, and the system of Werner made to coincide with the appearance.

7. The seventh formation consists of sand and sandstone, without shells. This sandstone is often found extremely pure, and furnishes a silicious sand that is useful in the arts: in other places it contains a mixture of clay, and is coloured by oxids of iron.

8. The eighth formation is of sandstone, and is distinguished by containing marine objects, of which sixteen are enumerated by M. Cuvier, from Montmartre, Romainville, &c. There are therefore in the neighbourhood of Paris, three different formations of sandstone.

When we look back on the series of beds which have been enumerated, the idea of a sea, which has deposited at its bottom an immense mass of chalk, and of marine objects of different species, forces itself on the imagination. The precipitate of chalk, and of the remains which accompany it, ceases all at once; the beds which succeed are of a nature entirely different, and consist of a deposition of clay and sand. Another sea, or the same, furnished with new inhabitants, now exhibits a prodigious quantity of testaceous mollusci, altogether different from those of the chalk, and forms at its bottom vast beds, composed in great part of these testaceous remains.

By degrees, the quantity of those shells diminishes, and at length ceases entirely; the sea has retired, and the earth is covered with fresh water. Alternate beds of gypsum and marl are now formed, involving the shells of the fish which inhabited these lakes, and the bones of the quadrupeds which lived upon their banks.

Next, the fresh water disappears; the sea returns, and brings with it certain species of bivalve and turbinated shells, which afterwards cease, and are replaced by oyster shells. An interval of time then took place, during which nothing but sand was deposited: either, therefore, no organized bodies were contained in that sea, or their remains are entirely destroyed.

At last, the sea retires a second time; lakes and marshes of fresh water succeed, and cover with the remains of their inhabitants the summits of the hills, and the surfaces of the plains between them. Such is the series of vicissitudes which, in the strata here described, has left so many unequivocal monuments of its existence!

9. A milstone formation without shells. This rock is a silex, filled with a multitude of irregular cavities, traversed by silicious threads, disposed like the reticulated structure of a bone, and covered with a coat of red ochre. These cavities are often filled with argillaceous marl, or argillaceous sand; they never communicate with one another; are never lined with mammellated silicious incrustations, like chalcedony, nor with crystals of quartz. These last characters, independently of its position, are sufficient to distinguish it from the milstone beds, derived from the silicious limestone already mentioned.

Another geological character of this rock is, the entire absence of all organized remains, animal or vegetable, belonging either to fresh or salt water. Chemical analysis shows it to be composed almost entirely of silex.

We are glad to present our readers with so distinct an account of the geological characters of a stone, so valuable in the arts, and formerly so much used in England, as the milstone, or buhr of Paris.

10. A second fresh water formation. This is composed of two sorts of stone, the one silicious, and the other calcareous; which are sometimes found separate, at other times mixed, and as if kneaded together.

Whether the formation we now speak of is marly or compact, it often contains irregular cylindric cavities nearly parallel, though crooked. These resemble exactly the cavities that might be left in a mass of thick mud, by bubbles of gas rising from the bottom to the surface. The greater part of the shells found in this stratum,

have been particularly described by Brongniart, in the 15th volume of the Annales of the Museum. They belong all to rivers or lakes; such as the Potamides Lamarkii, Planorbis of various kinds, Limneus, Helix, &c.; together with many specimens of silicious wood, of reeds, seeds, &c. amounting in all to twenty different species.

11. The 11th formation consists of unconsolidated earth, viz. sand, marl and clay, mixed with coaly matter. It contains also gravel: but the objects which particularly characterize it, are the remains of large organized bodies, such as trunks of trees, bones of elephants, oxen, rein-deer, and other large mammalia.

It is probably to the existence of these organized bodies, not yet entirely decomposed, that we must attribute the dangerous, and often pestilential emanations disengaged from this earth, when removed for the first time, after the long series of ages which have elapsed since its deposition. For it is with this formation, which appears so modern, as with all that are before examined. Though very recent, in comparison of the others, it is yet anterior to all historical record; and we may gather from it, that the earth, or ruin of the ancient world, did very little resemble that of the present; since the remains of plants and animals found in it are entirely different, not only from those of the countries where it is found, but from all that are known at present to exist.

We have now given an abridgement of the first part of this valuable and interesting memoir. The second part consists of a minute, geographical detail of the places and circumstances, in which the phenomena above described have been particularly observed; into which it is not possible, in an abstract such as this, to enter with any great effect. We shall, however, endeavour to give a general idea of the sections, and the mineralogical chart with which the essay is illustrated.

The vertical sections of a country, horizontally stratified, convey much more information concerning its structure, than the horizontal section, or the map of the mere surface. The reason is obvious. A vertical section is transverse to the strata, and gives a view of their order of succession, their thickness, their depth under the surface, &c. A horizontal plan tells only what particular bed happens to be at the surface, at a particular place, a circumstance that may depend on accidental or foreign causes, that have determined

the waste or decomposition of the rock to be greater at one place than another. Hence the great value of the vertical sections of a country horizontally stratified, a matter of which the geologists employed in the construction of mineralogical maps do not seem always to have been sufficiently aware. M M. Cuvier and Brongniart, have, however, been aware of it, and have accompanied their survey with eleven vertical sections of the country round Paris, as well as a mineralogical map, in which the formations that are at the surface are distinguished by different colours. On this map, they have also laid down the lines in which their sections are made. It will be readily understood, that in forming a section of this nature, information cannot be obtained, except at points considerably distant from one another, at those, viz. where natural operations may have laid bare the strata, or where art may have done the same, by sinking mines, working quarries, digging wells, &c.; or where the mineralogist, in pursuit of knowledge, may have bored, or cut into the interior of the earth. The constitution of the interior, at these different points, is all that actual observation can ascertain: the geologist must fill up the intervals between, as the astronomer does the intervals of his observations, by attending to the law which the things actually observed, when compared with one another, appear to obey. The greater the number of the observations actually made, and the greater the consistency of the results, the greater is the evidence that the things which remain concealed, resemble those which have been actually discovered. The sections we refer to are estimable on both these accounts; for the points of examination are numerous, and the conclusions to which they lead, have a remarkable conformity with one another. One of the sections is an ideal one, containing as it were, the mean result of all the rest; and it will serve therefore better than any other, to give our readers a general notion of the relative thickness of the strata, as well as of their position.

The level from which the heights are reckoned, is that of the Seine, at the Pont de la Tournelle. We shall give the measures in metres, observing that where great accuracy is not required, they may be reduced to yards, by considering that a metre is to a yard, as 13 to 12 nearly *. The upper surface of the chalk is represented

* The ratio of 131 to 120 is more exact.

as undulating, but as having its average height very little below the level just mentioned. The section below this level is wholly on the chalk, and extends to the depth of 34 metres. The plastic clay covers the chalk to the height of 12 metres; the coarse limestone with shells, and the collateral silicious limestone without shells, are of the thickness of 34 metres. The whole of the fresh water formation above this, occupies a space of 43 metres. The beds of this formation, containing the sandstone without shells, and some other thin beds, occupy altogether 42, the millstone formation 12, and the uppermost fresh-water formation 11, making in all about 180 metres, (196 yards,) from the lowest point of the chalk. What is called the *limen d'atterrissement*, or the earth that covers the surface, is not included in the section.

The first of the real sections is one carried from Notre Dame, to Lonjumeau, south from Paris, and a few degrees to the west, the distance being a little more than 18 kilometres, somewhat more than 11 English miles. The strata above enumerated are seen in this section on levels, considerably different from those in the ideal section, but having nearly the same relation to one another. The section through Lonjumeau passes also through the observatory, and shows the depth of the caves that belong to it. The height of the floor of the observatory is about 66 metres above the level of the Seine, at the bridge abovementioned; and the caves, to which you descend by a perpendicular shaft, are 60 metres under the surface. These caves are in the coarse shell limestone, which is the third of the preceding formations. The highest ground in this first section is the Plateau de Verriere, where the uppermost fresh-water formation is found covered with sand, at the height of 115 metres, or 124 yards, above the level of the Seine.

The second vertical section extends from Paris, north-west to Montmorency, a distance of about 21 kilometers, or 13 English miles, and contains several very satisfactory exhibitions of the different formations, though not so complete as the preceding, as it does not go below the level of the river, and consequently does not extend into the chalk. We shall not attempt any enumeration of the rest.

Any idea that we can convey, in words, of the horizontal plan, or mineralogical chart, is still more imperfect than of the vertical sections. This plan expresses, by means of colours, the different

formations that compose the superficies in all the tract to which the map extends, that is, for a space of 14 myriameters, or 87 miles in length from east to west, by 12 myriameters, or 74 miles in breadth from north to south, a superficies of more than 6400 square miles.

To the eastward of Paris, in the space between the Seine and the Marne, and for a considerable way to the south of the former, towards Fontainbleau, &c. the silicious limestone of the fourth formation prevails very generally, and occupies a circular space between 30 and 36 English miles in diameter*. This extensive tract is bounded to the east and north-east, by the plastic clay, or second formation, which extends in those directions beyond the limits of the map.

Immediately round Paris, on the north of the Seine, the formation, at the surface, is that from the fresh water above described. This extends to the distance of three and a half myriameters, occupying nearly the whole of the space between the Marne and the Oise, and bounded both on the north-east, north-west, and south-west, by two very extensive districts of the shell limestone of the third formation. A little farther to the north, on both sides of the Oise, the chalk reaches the surface for a considerable extent; but still farther to the north, is succeeded by the plastic clay. A great tract of country on the south-west of Paris, about Epernon, Dourdan, and Estamps, consists of the millstone or buhr formation. If to these we add a considerable tract of gypsum round Versailles, and another of the same substance, having Lonjumeau nearly in its centre, we shall have a tolerably exact notion of the extent and bearing of the principal tracts, in which these different formations are exhibited at the surface.

One of the circumstances which must strike every one in considering the facts above described, is the alternation of salt and fresh-water productions, which seems so little to agree with any thing that theory can suggest. The successive changes of level that must thus have taken place, are very hard to be understood; and, whether they are to be ascribed to the alternate rising and falling of the land, or to the alternate falling or rising of the sea, are discussions which must be left to future enquiry. The Parisian strata

* All the measures not expressed in French names are understood to be English.

contain, however, undeniable proofs, and the only proof that has yet appeared, that the relative level of the sea and land has been more than once changed, even in the later geological periods in opposite directions; in a word, that there is a vibration backward and forward, in what seems to us of all things the most stedfast, arising from causes about which we can form only imperfect conjectures.

The existence of species, and even genera, of animals, in the very remote ages of the world, that are now unknown, has already been inferred from the examination of the bones contained in these strata; and we are glad to present our readers with so much accurate information concerning the substances in which those bones are found. It is not a little curious to consider, that since these animals existed, the land on which they dwelt has been again immersed under the waters of the ocean, and has remained so long under it as to be now covered by a bed of oyster-shells, two thick beds of sandstone, and the hard silicious rock, which constitutes the millstone formation. Far back as this reaches, with regard to the natural history of the earth, the deposition of the strata in which these bones are contained, nay, even of the chalk, the basis of the whole, is recent, compared with the rocks of intermediate or primary formation.

In the bones contained in the plaster or gypsum formation, we have the most ancient monuments of land animals that are yet known to exist, and on account of their great antiquity it is perhaps less wonderful that they resemble so little any of the animals now inhabiting the earth. The genera and species of animals that inhabit this globe are evidently subject to change; some are entirely extinguished.—As old species perish, do new species rise up! Is there some secret law of animal reproduction by which there is a succession of species in the course of ages, as there is of individuals in the course of years!—The mind is lost amid the uncertain lights and gigantic images that pass before it; and, on awakening as from a fearful dream, sees nothing satisfactory, but one mystery more added to the thousands that are already around it *.

[*Edinb. Rev.—Essai sur le Geographie Mineralogique des Environs de Paris. Par G. Cuvier et Alex. Brongniart.*

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* A somewhat similar sketch has been given by Mr. Parkinson of the "strata and fossil Remains near London," by Dr. Filton, "of the Geological Struc-

SECTION IV.

FOSSIL UTENSILS, ORNAMENTS, AND BUILDINGS.

1. *Roman Antiquities in Lincolnshire. By the Rev. Abraham De la Pryme.*

I HAVE observed many Roman ways in Lincolnshire, but none more observable than that called High-street, which I think runs almost directly in a straight line from London to Humber-side. This High-street is so visible, that it is a great guide to strangers and passengers. It is cast up on both sides to a great height, and discontinued in many places, and then begun again, and so on to Humber-side. I have observed that where it runs over only bare mould and plain heath, that it consists of nothing but earth thrown up; but where it runs through woods, it is not only raised with earth, but also paved with great stones set edgewise, so very close to each other, that the roots of the trees that had been cut down to make way for the same, might not spring up again and blind the road.

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ture of the Vicinity of Dublin," and by Mr. Leonard Horner "on the Mineralogy of the Malvern Hills," all contained in the very valuable volume lately published (the first and promising fruits of this public-spirited institution) by the Geological Society: but of too scientific a nature for a popular work. We may, however, venture to extract the following concluding paragraph from Mr. Parkinson's paper, containing a comparative view of the general oryctognosy of London and Paris. "On comparing the preceding sketch with the Essay on the Mineralogical Geography of the neighbourhood of Paris, by Mess. Cuvier and Brongniart, some important variations will be perceived between the strata found above the chalk in this island and in France. In France, the strata above the chalk differ both in number and quality from those which have been hitherto observed in a similar situation in England. In France too, general strata of sand and sand-stones exist above the strata of the gravel formation, which, in this island, appear to be the highest.

"The first of these differences appears to result chiefly from the existence of numerous beds or patches, the formation of which must have depended on certain local circumstances, such as the existence of fresh or salt water lakes, at the period of the drying up of a former ocean; the different chemical combinations which might thence have taken place, &c. But the occurrence of such variations can hardly be considered as interrupting the continuity of the stratification.

"Indeed, when it is considered, that in France much more frequent opportunities are afforded of examining the stratification immediately above the

This paved causey is still very strong, firm, and visible in many places of this street, where woods are yet standing on both sides, as undoubtedly they were in the times of the Romans, else it had not been paved; and, in some other places, it is paved where no remains of wood is now to be seen, though undoubtedly there was when it was made. In one place I measured the breadth of the said paved street, and found it just seven yards broad, English measure.

This street or causey, in its course full north, runs by the fields of Hubberstow, which perhaps signifies the place where the Danish General Hubbin was buried; in which fields, not far from this street, are the foundations of many Roman buildings to be seen, as is manifest from their tiles found there, and according to tradition there has been a city and castle in that place; and there are two springs, the one called Julian's stony well, and the other Castleton well; and several old Roman coins are now and then found there. This might, perhaps, be some little old Roman town by the highway side, and, in after times, before that it was ruined, called Castletown, or Casterton, from its being built upon or near some of their camps, which might then be in those fields.

About a mile further to the northward, on the west side of the said street, on a great plain or sheep-walk, the foundations of another old town are very visible; though now there is neither house, stone, rubbish, tree, nor hedge, to be seen belonging to it. I counted the vestigia of the buildings, and found them to amount to about one hundred that are still visible; and the number of the streets or

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chalk than in England, it will not be regarded as improbable, that several of these beds or patches may exist here, the discovery of which would render the accordance of the two series of the strata much more close.

"Even from the examinations which have been already made, the identity of the French and English chalk is established. The British strata above the chalk are also found to contain patches of plastic clay, of most of the varieties mentioned in the French strata, as well as patches of coarse limestone, with its accompanying sand and its peculiar fossil shells, such as are found to exist in the corresponding French strata.

"The other difference, the existence, in France, of beds of sand and of sandstone, above those of gravel, which are the lightest strata of this island, is very remarkable. May it not be attributable to the abruption, from this island, of the superior strata or beds of this formation, by that catastrophe, instances of the astonishing force of which have been already noticed?"—*Editor*.

lanes is four or five; and not far from it northward is a place called the Kirk-garth, where the church is supposed to have stood that belonged to this town. Tradition calls this place Gainstrop, and vol. ii. of the Monas. Angl. shows that there were lands and tenements herein, given to Newsted priory, not far from this place, in an island in the river Ank, falsely called Ankham.

About a mile or two hence the street runs through Scawby wood, where it is all paved, and from thence close by Broughton, by a hill which seems to be a barrow, from which the town had its name, quasi barrow town, but that it seems to be too excessively great for one. However, I have found fragments of Roman tiles and bricks there, and millions of petrified shell-fish.

From thence the causey, all along paved, is continued about a mile further, to the entrance upon Thornholm, where there is a place by the street called Bratton Graves, and a little to the east near Broughton-wood side is a spring that turns moss into stone; and a little further stands the ruins of the stately priory of Thornholm, built by King Stephen. Opposite to this priory, about a quarter of a mile on the west side of the street is a place called Santon, from the flying sands there, which have over-run and ruined above a hundred acres of land. Among these sands was, in ancient times, a great Roman pottery, as Dr. Lister shows from the relics of ruinous furnaces. and many fragments of Roman urns and pots still to be met with. I have also found there several Roman coins, and a large piece of brass found in the bottom of one of the furnaces, like a cross, which perhaps was part of a grate to set some pots on, while they were baking or drying.

Returning back to the street, there are several sand-hills, somewhat like barrows, on the top of one of which was erected a great flat stone, now so far sunk in the earth that there is not above a foot of it to be seen. Entering then into Appleby-lane, the street leads through the west end of the town, where two old Roman games are still practised, though very imperfectly, the one called Julian's Bower, and the other Troy's Walls. From hence the street runs straight on, leaving Roxby, a little town half a mile on the west, and Winterton, a pretty neat town. And then about three or four miles further, leaving Wintringham about half a mile to the west, the street falls into the Humber, and there ends; at which end has

been a town called Old Wintringham, and a sort of a beach for ships.

All the part of the country on the west side of this street has been occupied by the Romans, as may be gathered from the medals, coins, and the many tiles and bricks that are commonly here found, especially at a cliff called Winterton Cliff, where some old Roman buildings have stood; and further about two miles more to the west is Alkburrow, which seems to have been a Roman town, not only from its name, but from a small four-square camp or entrenchment there, on the west side of which is a barrow called Countess Barrow or Countess Pitt, to this day, hollow in the middle.

In the town of Roxby is a close, or garth, where a Roman pavement was discovered, on the south-west of the church. The occasion of its discovery was the tenant digging to repair a fence between this close and another; as soon as he had discovered it, he bared a little of it, and it lay about a foot and a half in the ground, and on digging in many places he found it about six or seven yards broad, and as many long, if not more.

Having got a spade, shovel, and besom, we fell to work, and with a great deal of labour (the ground being very hard) bared about a yard and a half square; by which we cast up many pieces of Roman tile, the bone of the hinder leg of an ox or cow broken in two, and many pieces of plaster painted red and yellow, which seemed to have been the cornish at the foot of some altar, or perhaps of some part of the building; and we observed that several great stones in their falling, when the building over this pavement was destroyed, had broken and lodged themselves in the pavement. Then having swept the space thus bared very clean, the pavement looked very beautiful, and one could not imagine that such mean stones could make such pretty work; being nothing but small square bits of brick, slate and cauk, set in curious figures and order, and only of three colours, red, blue, and white. Several whole rows of red, blue, and white on the outsides of the smaller work, consisted of pieces twice as long as the rest. The material that these small stones is set in, is a floor of lime and sand, and not plaster; which floor is so rotten and decayed with time, that the little stones, &c. are easily dug up.

The whole pavement consists of circles, and quadrangular and

many irregular figures, with rows of the aforesaid stones, red, blue, and white: in some of these circles and figures there are urns, in others flowers, and in others interchangeable knots, according to the workman's fancy.

[*Phil. Trans.* 1700.]

2. *Roman Camp at Castor in Norfolk. By Mr. William Arderon.*

The town of Castor is at present in a very low condition, containing no more than between twenty and thirty small cottages. It stands about four miles south-west of Norwich, and by tradition, and some learned authors, is supposed to have been a considerable city, out of whose ruins Norwich took its rise. However, at this day, excepting the camp, not the least trace or footstep of any thing remarkable is left remaining.

The camp itself lies near a furlong south-west from the town of Castor, and leads you by a gentle descent down to the little river Wentsum, which swiftly glides close to the end of it, and doubtless at the first forming of the camp was designed to be part of the fortification on that side, as well as to supply the army with water, and to bring up such things as they wanted from the sea, if their communication by land should at any time be impeded. This river is by some called Taus, or Tese: but probably it did not formerly take that name till it approached the Roman camp at Teseburg, three or four miles higher.

We are told by tradition, as well as by some learned authors, that the sea came up to this camp; and indeed every intelligent observer must confess, that the marine bodies found in every part of Norfolk, on the highest hills, as well as in the lowest pits and valleys, are indubitable proofs, that at some time or other the sea must have covered this whole country; but then we may be assured by the present condition of this camp, that the sea has not exceeded the level of it since it has been in being, which, if we credit several of our ancient historians, it was upwards of 1700 years ago. It may therefore serve to prove, that the sea since that time has not exceeded these bounds, and that the fossils dug up above this level are more ancient than it, though we have no proper data to discover how long before the sea had passed this height.

The figure of the camp is not a square, but a parallelogram, whose two longest sides are each 440 yards, and its ends or two shorter

sides 360 yards each. These are its dimensions withoutside the rampart and ditch; but within the length is 392 yards, and the breadth 264. The breadth of the fosse and rampart, in some places where it remains most perfect, was 48 yards, though in others not above 30. And the whole ground taken up, including the ditch and rampart, is 32 acres, 2 roods, and 36 poles; or the area within the ditch and rampart 21 acres, 1 rood, 21 poles.

Three sides only of this camp have been fortified with a rampart, whose upper part was faced with a thick and strong wall, made of lime and flints; of which wall there are still remains in several places of the rampart, besides a very deep ditch, that seems to have been most considerable on the east and south sides. The wall on the north side appears to have been built at two different times; that is, it seems to have been raised higher than it was built at first, at some distance of time afterwards; for a parting may be observed at a certain height running from end to end.

The ruins of two old towers still remain, one of which stood on the north side, and the other at the west end; the last of which is at present the most considerable of the two. They were both built in a manner perhaps peculiar to the Romans at that time, and which it may not be improper to describe. They began first with a layer of bricks laid flat as in pavements; on that they placed a layer of clay and marl mixed together, and of the same thickness as the bricks; then a layer of bricks, afterwards of clay and marl, then of bricks again, making in the whole three layers of bricks and two of clay: over this were placed bricks and lime twenty-nine inches, the outside being faced with bricks cut in squares, like the modern way of building in some parts of Norfolk, then bricks and clay, again stratum super stratum, as high as the old ruins now remain standing.

The mortar is found extremely hard at this day: it is a composition of lime, sand, and ashes, and so compact, that he could by no means break a piece of it, of an inch diameter, from the base of one of the towers at the east gate, but on striking it with a sharp flint it flew off in dust.

The Roman bricks which he examined, were made of two different sorts of clay mixed; when burnt, one appears red and the other white: at the time of viewing them, they were exceedingly hard and solid, and far superior to any thing of the kind now made with

us. Perhaps they are little worse than when they were first laid down. These bricks were made without the assistance or addition of sand, as is too much the practice at present here in Norfolk: for when sand enters the composition in any considerable proportion, it renders the bricks friable, soft, and rotten, subject to be broken or ground to pieces with the least motion or pressure. The length of these bricks is $17\frac{4}{10}$ inches, or a Roman foot and half; and their bread $11\frac{6}{10}$ inches, or precisely a Roman foot: which may serve as some proof that the Roman measures, handed down to us by several authors, are right, and may likewise inform us of the proportionable stature of man at that time. The thickness of these bricks is $1\frac{2}{10}$ inch.

The great number of Roman medals that have been, and still are found in and about this camp, are a matter of great wonder. One lady who lives near the place, has, it seems, picked up at least one hundred; and several are daily gathered up by boys, and sold to strangers who come to visit the place. That these pieces have been used as money seems exceedingly clear, from their different degrees of perfection; some being worn almost quite smooth, others having imperfect busts without letters, and others again having both the busts and inscriptions fair and legible, which could only happen from their different wear as money.

[*Phil. Trans.* 1749.]

3. *On the ancient Town Delgovicia in Yorkshire, By Mr. Thomas Knowlton.*

Within four miles of this place (Londisburgh) have lately been discovered many foundations in a ploughed field, which have lain buried for many ages, and without any records or tradition of it. It was discovered by a farmer at Millington, as he formerly tended his sheep on one side of the hill, and on the opposite side had perceived in the corn a difference in colour for some years before, which led him this summer to dig; and happening on the foundations, it encouraged him, with Dr. Burton and myself, to dig likewise in several places; and in one part was discovered a circular foundation five feet wide, and the plan within forty-five feet diameter; which it seems was a temple dedicated to Diana, said to have been at Goodmanham; but no appearance of it there was ever found. The distance from Goodmanham to Millington, is about five miles;

and there were likewise many other foundations which had great quantities of Roman pavements within them; by which probably, after the dissolution of the temple, it became a Roman station, then called Delgovicia; which has been fixed at Goodmanham, Londisburgh, Hayton, &c.: yet not the least remains ever appearing at any of those places, so as to satisfy an indifferent inquirer; but in this just now discovered, the ruins and foundations are a demonstration of the once grandeur of the place; and doubtless it was the abovementioned Delgovicia. The foundations lay about eighteen inches below the surface, and to the depth of four or five feet within the ground; and are on the Wolds Hills, within two miles of Pocklington.

Within a mile and a half of Kilham, is a place called Danes Graves, near which it is supposed was fought a great battle, in which vast numbers fell; and so were laid in heaps, and covered with the chalky soil in little tumuli, of the space of two or three square yards, in which are found great quantities of human bones; and now there is not less than an acre of ground covered over with them, joining close to each other; and it is one of the greatest curiosities of antiquity ever seen.

About five miles from thence, in Rudstone church-yard, there stands up, on the north-east end of the church, a large stone, thirty feet above ground, and what depth within is not known. Neither is it known on what account this vast obelisk was brought over land, so far as it must have been; because we have no quarries of stone nearer than twenty miles of the place. All the wolds are barren of such materials: it is five yards about, and of a parallelopiped form.

Additional Remarks on the same subject. By John Burton, M. D.

The learned antiquarians have hitherto been greatly at a loss to find the place where the Delgovicia of the Romans really stood; some supposing it at one place, and some at another.

Mr. Francis Drake, in his excellent History and Antiquities of York, has given every thing which has hitherto been written in support of the claim made by each place to the honour of rising out of the ruins of that ancient town, with his reasons for fixing that station at Londesburgh; all which need not now be repeated.

There are three places where the site of Delgovicia has been fixed

at; viz. Weighton, Godmanham, and Londesburgh. But Dr. Burton dissents from Mr. Drake, and thinks that Delgovitia was not at any of those three places, for several reasons which he thinks make against that supposition. But he rather thinks its situation near the town of Millington. For this place is best adapted by nature for the defence of the country: here also are found the remains of old military works. All these works inclose 4185 acres of ground; whence it is evident here must have been a large army. We see in several places where their tumuli or barrows were represented by little green hills.

Having shown the fortifications and out-works of the camp, he next endeavoured to prove the part within these on which Delgovitia stood. About half a mile north-east of Millington, on the south side of a gently-sloping hill, were found several stone foundations of buildings of different sizes, and of different shapes; among which were found several fragments of Roman pavements, Roman tiles, flues, and two Roman coins. These are all proofs of the buildings having been Roman. There was likewise dug up a piece of a large stone pillar, of about six feet in length, but of no regular order; which notwithstanding might yet be Roman; for we cannot suppose those military people so well skilled in architecture as the artists at Rome.

If Delgovitia, as Cambden hints, be derived from the British word *delgwe*, which signifies statues or heathen gods, this place may lay claim to a title on that account, much sooner than either Weighton or Godmanham; for here was dug up a circular foundation resembling a temple in all appearance; being forty-five feet diameter within, and the foundation was near five feet thick.

Near to this circular building, but south of it, were the foundations of two oblong square buildings, but with a strait entrance, not two feet wide, in which probably they put in the fuel and fire for their sacrifices; there being evident marks of burning on the stones, being almost burnt through; also, in digging in the middle of these two buildings, were found about half a yard thick of ashes, with some few small pieces of wood, fuel, and pieces of brute bones, chiefly burnt, and a great part of a horn of a large deer. East of these were laid open the foundations of another square building, where were found various pavements, coins, &c.

From what has been said, he thinks there is nothing wanting

now to prove this to have been the Delgovitia, but to reconcile the distance as mentioned in the Itinerary. This he does pretty nearly, by an actual measurement.

He thinks it is evident that neither Weighton, Godmanham, nor Londesburgh, stand where Delgovitia was. He has in the first place shown the probability of this place near Millington being the station, from the known prudence of the Romans, because one set of men could defend the whole four passes; which could not have been done, had they been placed at Weighton, Godmanham, or Londesburgh. 2. He has shown that from the very situation and nature of the country, there required but little art to make their camp at that time almost impregnable; the valleys in general being from sixty to ninety yards deep, and their sides very steep. 3. That from this camp and Londesburgh they might see the whole country from the Humber on the south-east, up the vale of York on the west towards the north-west side; so that no army could surprise them that way. 4. That they could always have a sufficient quantity of provisions, and never want water, even in the hottest summers. And, 5. That there has been a Roman station here, as is evident from the Roman pavement, coins, tiles, and foundations of the ruins; and if the Romans had a station at Weighton, Godmanham, or Londesburgh, they would scarcely have had one so near the other.

All these things concur in proving this to be the site of Delgovitia; and there is or can be no argument brought against it; except that, by the Itinerary, the distance from Eboracum by Derventio, is set down at 20 M. P. and by our measure the distance from York to the circular foundation in the camp, is only $17\frac{1}{4}$ miles, and 55 yards; so that there is above $2\frac{1}{2}$ measured miles difference. In answer to this, he says, may not the Itinerary be as wrong here as in some other places, which is very evident in several instances? and as it is wrong in some others, doubtless it may be so in this: besides, the Romans might calculate from the centre of York; and this mensuration only goes from the bar at Walmgate to the circular foundation in the Roman camp. But supposing the Itinerary to be exactly right, yet when the difference between the Roman Mil. Pass. and our miles is calculated, he thinks it will end all disputes on that score.

An Appendix to the foregoing Paper. By Mr. Fr. Drake, F.R.S.

Time, which subverts and destroys the greatest works of mankind,

has an equal property of bringing things to light. The Delgovitia of the Romans in this country, so long sought after by Cambden and other writers, is at length discovered so far, that there is no need of any more conjecture about it.

Being informed, in the year 1745, of some Roman curiosities found in a field near Millington, on the Wolds, Dr. Burton of York and myself set out to survey them. On our coming to the place, an intelligent countryman and his father conducted us to a large plain field, on the south side of Millington wood, where they showed several foundations of buildings under ground, on the very stones of which the apparent marks of fire may be traced. Two bases of pillars, of an irregular order, and a large piece of a column, were also discovered; several pieces of tessellated pavements, Roman bricks, tiles, &c. were dug up. The father said that, about forty years before, he saw the foundations of a circular building, about fifteen yards diameter, dug up in this place; which must have been the vestiges of some circus or temple; that it had been the custom for the inhabitants of their village, time out of mind, to dig for stones in this ground when they wanted; and which they must often do, in a country almost clear of such materials. The church of Millington itself seems to have been built out of the ruins of this ancient Roman station.

That this was really the Delgovitia so long sought after, is beyond contradiction. The distance from York coincides very justly with the Itinerary; nineteen or twenty Italian miles agrees pretty well with our present computation; and at the same time points out the true military way from the Humber to York. Instead of forcing a road through the vale, the Romans very wisely chose to mount the hills as soon as possible; and therefore directed their stratum from York to the ford, over the river Derwent at Stainfordburg; and from thence in a direct line to Garrowby hill; which I take to be corrupted from Barowby, many of those tumuli or barrows being near this place. On the top of this mountain, though the road turns up it by an easy ascent, begins a series of such enormous works for fortification, as the like is not to be met with in the whole island.

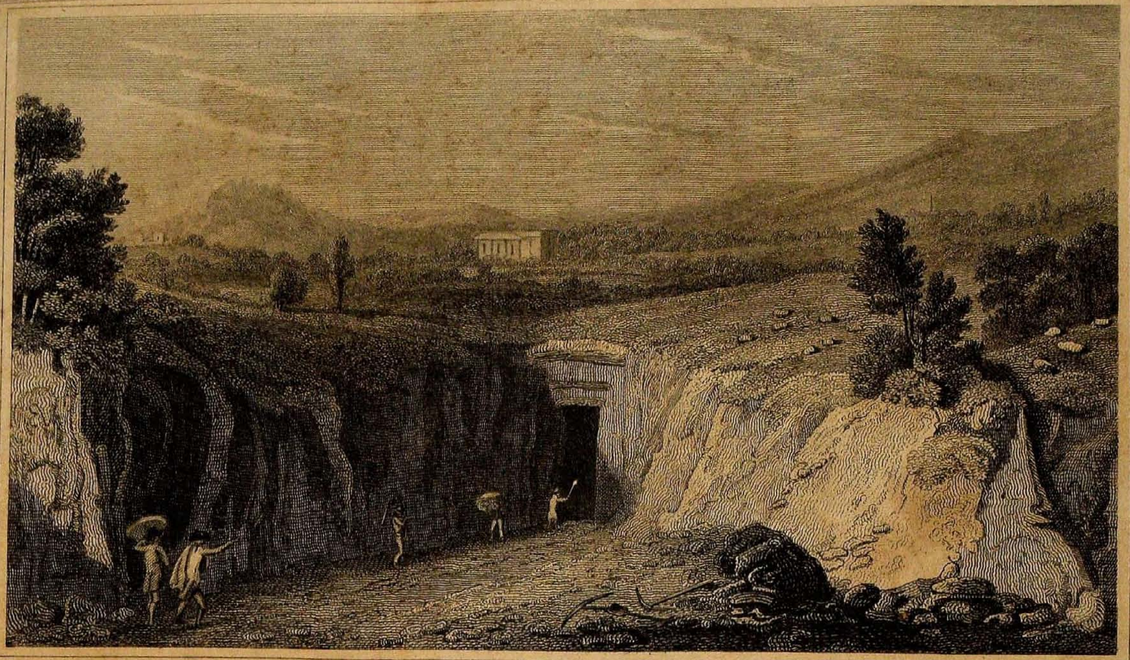
This road, on the summit of the hill in a straight line, points directly for Sureby or Burlington bay, the Sinus Salutaris of Ptolemy. But another road to the right takes a different course, and comes

down to the ruins before-mentioned. Thence the road leads directly to Londesburg, the place which I once thought the station sought for; it passes through Lord Burlington's park, where more of it was laid open last year than I had before seen, in widening the large and noble canal in that inclosure. This place was before a morass, and the Romans were obliged to force a way through it, which is eight yards broad, and laid with stone edgeways to a great depth. The road passed up the hill on the other side this marshy place, and divided into two branches on the top of it; one way pointing through Weighton to Brough on the Humber, and the other by the east end of Godmondham directly for Beverley; which now I am convinced also was the Petvaria of Ptolemy. From which last station it must have gone out directly for Patrington or Spurnhead; one of which was certainly the Roman Prætorium, mentioned as the last stage in the first itinerary route of Antoninus.

This sea-port must be very commodious to touch at, either going or returning from Gaul, or the Belgic coasts, and bringing military stores, &c. from thence, either to York or Malton; to which last place the Camolodunum of Ptolemy, another road branches out, apparently from the conjunction on the top of Garrowby hill, and leads directly to it. But to return to our Delgovitia.

The situation of this place is admirable, and the stupendous works about it, thrown up for a defence to this station, and the several grand roads near it, are not to be described. The town itself was placed on a declivity of a hill, almost full south; and very near its ruins arise some rapid springs of excellent water; and so copious, as, when joined in one stream, turns a mill; from which probably the name of Millington has proceeded. There was also lately discovered a well, above a mile E. by S. from these springs, dug through the solid rock, twenty-six yards deep, which must have been a Roman work.

To the south-west there are no ramparts thrown up; but to the east, north-east, and due north, the whole country is full of them. The vales are all guarded by small encampments at their angles; the vestiges of the barracks, now visible, are called by the country people the camps. These were to prevent any sudden surprise that way. On the hills, from vale to vale, some of which are from sixty to ninety yards deep, and prodigiously steep, are thrown up works, as ramparts, twelve yards broad, and proportionably high, which



Engraved by Lacey, from a Drawing by Craig

For the Gallery of Nature & Art

EXCAVATION LEADING TO THE REMAINS OF HERCULANEUM.

London, Published by R. Wilks, 89, Chancery Lane, Nov. 1st 1814

join in right angles with the vallies, and serve as a strong barrier every where.

[*Phil. Trans. Abr. Vol.* IX.]

4. *Ruins of Herculaneum.*

The destruction of this city, by the dreadful eruption of Vesuvius of the year 79, and its total burial beneath the stones, ashes, and lava, which, on that occasion, were ejected in fearful and stupendous abundance, we have described *. From this remote period, not a vestige of its buildings or even situation could be traced by the keenest antiquary or geologist till the year 1729, when a part of its ruins were discovered by accident, and in the ensuing year the overwhelmed city was found to be accessible by a well. This singular discovery, at a distance of sixteen hundred and fifty years from the disappearance of the city, together with the curious and valuable antiquities which it brought to light, cannot but be regarded as one of the most important facts in general history, and as such we shall give a detailed account of it from the principal papers upon the subject, which were successively published in the Philosophical Transactions, where one of the best and most authentic statements is to be met with. The first hint at this important discovery is contained in the following note by William Sloane, Esq. in the volume for 1740.

At Resina, about four miles from Naples, under the mountain, within half a mile of the sea-side, there is a well, down which, about thirty yards, is a hole, which some people have the curiosity to creep into, and may afterwards creep a good way under-ground, and with lights find foundations of houses and streets, which, by some it is said, was, in the time of the Romans, a city called Aretina, others say, Port Hercules, where the Romans usually embarked for Africa. Mr. S. has seen the well, which is deep, and has a good depth of water at the bottom; that he never cared to venture down, being heavy, and the ropes bad. This city, it is thought, was overwhelmed by an eruption of the mountain Vesuvius, not sunk by earthquakes, as were Cuma, Baiæ, Terpergola, &c.

The importance of this discovery was justly estimated by the Neapolitan court; and the king immediately formed a literary establishment under the name of the Herculaneum Museum, and ap-

* See Book II. Chapter IX.

pointed Signor Camillo Paderni, an antiquary of deserved renown, to the office of Royal Keeper of the Museum. This accomplished scholar was well known to many of our own countrymen in consequence of their travels and residence in different parts of the Neapolitan dominions, particularly with Mr. Allan Ramsay, Thomas Hollis, Esq. and Dr. R. Watson; and in his correspondence with these gentlemen, translated and published in the Philosophical Transactions, he gives a good chronological account of the progress of himself and his colleagues in clearing the rubbish, unfolding the buildings, and collecting their curious and valuable remains. This account is as follows; taken, for the sake of brevity, from the most summary language of the Abridgment.

November 20, 1739. The King of Naples has lately made a discovery of a subterraneous town at Portici,* a small village at the foot of Mount Vesuvius; and our old friend Sign. Gioseppe Couart, as sculptor to the king, has the care of the statues found there, with orders to restore them, where they are damaged. He tells me, they enter into this place by a pit, like a well, to the depth of 88 Neapolitan palms †, and then dig their way, after the manner of our catacombs, under the bituminous matter, thrown out of the mountain in the time of great eruptions, and called by the people of the country, the lava, which is as hard as a flint. And when they meet with any thing that seems valuable, they pick it out, and leave the rest. They have already found the following things:

An amphitheatre, with its steps; an equestrian statue, but all broken to pieces; a chariot and horses of brass, which have had the same fate; a large brazen dish, said to be found in a temple. They have also dug out many other bronzes, with several statues and bas-relieves, which Sign. Gioseppe is now restoring. There have been found likewise 8 rings, with their cornelians engraved, and a bracelet of gold. And they have already taken up about 30 or more pieces of ancient painting, some of which are exceedingly beautiful.

As soon as I arrived at Naples, Sign. Gioseppe met me, and carried me to Portici. The first thing he showed me, was the pictures they had dug out, such as were never seen in our days; being finished to the highest pitch, coloured to perfection, and as fresh as if they had been done but a month ago.

* See Philosophical Transactions, No. 456.—Orig.

† A Neapolitan palm contains near nine inches.—Orig.

Particularly one piece, 8 palms broad by 9 high, the figures as large as the life, representing Theseus after having killed the Minotaur, which is wonderfully fine. The figure of Theseus is naked and standing, which, in my opinion, cannot be more properly resembled to any thing, than the Antinous of the Belvidera, both for the attitude and air of the head. It is drawn and coloured with astonishing elegance. The Greek boys, who are represented as returning him thanks for their deliverance, seem, from their noble simplicity, the work of Dominichino; and the composition of the whole is worthy of Raphael. Another piece represents Chiron teaching Achilles to touch the lyre. Another large one, like that of Theseus, the figures as large as the life; but we could not comprehend the design of it. There is a woman sitting, dressed in white, with one hand resting on her head, adorned with a garland of flowers, and several deities, as they appear to be, in the air, with a black figure of Hercules leaning on his club. This figure is not of a piece with the rest, which are really prodigies of the pencil; but yet it is a fine picture. Under the woman is a deer, which gives suck to a child. This sitting figure, and the heads of those whom I take to be divinities, are exquisitely drawn and coloured.

Two other pieces of greater height and breadth, in which there are two figures, half human and half fish, which fly in the air. Four landscapes, with temples, and other buildings. Another figure, which seems to be Mercury, with a child in his hand, delivering it to a woman sitting. A tyger, with a boy upon it; and another boy, who plays on a tympanum. With many others.

After having viewed all these things, which are already taken out, I went down into the pit. The part where they are at work must have been a stupendous building; conjectured to have been an amphitheatre, by the circumference of the walls, and the large steps, which are still preserved. But it is impossible to see the symmetry of the whole; because one must travel through strait passages, like our catacombs in Rome. After having gone a good way under-ground, I arrived at the place in which the paintings had been discovered, and where they are daily discovering more.

The first mistake those men, they call intendants, have committed, is, their having dug out the pictures, without drawing the situation of the place, that is, the niches, where they stood: for they were all adorned with grotesques, composed of most elegant masques,

figures, and animals: which, not being copied, are gone to destruction, and the like will happen to the rest. Then, if they meet with any pieces of painting not so well preserved as the rest, they leave them where they are found. Besides, there are pillars of stucco extremely curious, consisting of many sides, all variously painted, of which they do not preserve the least memory. It is very curious to see these paintings all covered with earth, which when taken off, they appeared to have suffered nothing by it. I believe this may be accounted for, by their being no damp or moisture in the place; and that the dry earth has been rather preservative than hurtful to them. The ancient beams are yet discernible, but they are become like charcoal. And I have seen there a place where anciently they kept lime for building; a great quantity of which yet remains as fresh as if made but yesterday.

Extract of a Letter from Mr. Geo. Knapton to Mr. Charles Knapton, on the same subject.

THE ancient city of Herculaneum, which was swallowed up by an earthquake, is now under the town Portici, a quarter of a mile from the sea, at the foot of Vesuvius; and has no other road to it but that of the town-well, which is none of the most agreeable, being in some parts very strait, in others wide, and cut in a most rude manner. Toward the bottom, where you go into the city, it is very broad, which they have made so, to turn the columns, which were brought up; they began this excavation 27 years ago, and worked 5 years.

The principal things found were, two columns of oriental alabaster, which were sold for 50,000 ducats; also many fine statues, the best of which were sold, and some were sent to Lorraine. Five are set up in the market-place, all clothed figures, one in a consular habit, the others women; they are all well dressed, and in a fine taste, but want the heads. In the duke's villa, which is near and by the sea-side, are two others entire, both women; one seems to be a Livia; also the fragments of a naked figure, which wants the head and arms, of a good style. These, with some ornaments and fragments of various sorts of marbles, are all that is to be seen there of what has been dug up.

Having descended down the well, Mr. K. says, the place gives one a perfect idea of a city destroyed in that manner: for one there sees

great quantities of timber, in the forms of beams and rafters, some lying one way, some another; some, as they broke in the fall, others entire; these are sticking in the sides of the ways, and are become a perfect charcoal; but those in moist places, and where the water ouses, you may run your hand into, and work like a paste, and they have more the colour of rotton wood. The walls are some tumbled slanting, others crossing them, and many are upright. One sees great quantities of marble, as bits of window-cases and other ornaments, sticking out in all parts. There seem to be, in one place, the ruins of some magnificent building, which they have dug round; for there appear the bases in white marble of square and round columns, which are all of a size; and, what is surprising, they have not examined whether they have any columns on them, which one stroke of the pick-axe would have done. I scraped away the earth at the side of the base of a pilaster, and found the wall covered with a very beautiful marble, but could not reach to discover what was on the top of it. There are but two columns that appear, one of a red marble, the other of brick covered with stucco, and fluted. In one place there are about 14 steps, which resembled the seats of a theatre. Some of the walls have the plaster remaining, and are painted, the colours still fresh. One sees nothing but pure earth mixed with these ruins, whereas the surface of all that part of the country, quite to the sea, is covered with the cinders of Vesuvius. The buildings were of brick covered with marble; for I found no other sort of stone there, but thin plates of marble of all sorts in great quantity. Neither are there any bases or capitals of large columns: two feet diameter is the most. Captain Emmory brought away a small capital of a pilaster, which is very curious, it being much the same as was used by the Goths in Italy. This makes me think, that they revived the ancient barbarous style, used before the introduction of the Greek for the capital. This is certainly more ancient than the time of the Goths in Italy. It was the only one of the kind we saw there.

November 18, 1752. The things of which Signor Paderni says he had the charge, are many and extraordinary, consisting of metals: that is, bronzes, silver and gold of all kinds, of excellent workmanship. Beautiful cameos and intaglios. Glass of all sorts. Various productionsof the earth; such as grain, beans, figs, dates, nuts, pistachios, almonds, rice, bread. Colours for painting. Medicines in pills, and other forms, with their marks. A phial of oil. Gold

lace, perfectly well preserved, and extremely curious, on account of its being made with massy gold, spun out, without any silk, or other yarn. Soap, bran, and a variety of other things, which it were tedious here to enumerate.

There were found many volumes of papyrus, but turned to a sort of charcoal, and so brittle, that, being touched, it fell to ashes. Yet by his majesty's orders, he made many trials to open them, but all to no purpose; excepting some scraps containing some words, by which it appeared in what manner the whole was written. The characters are made with a very black tincture, exceeding the darkness of charcoal *.

There were found also very lately three beautiful statues of marble, and one of them excellent; six heads of bronze, of which here was one that gave hopes of finding the statue it belongs to. It is a young Hercules, of a kind of work that has no fellow in the way of metal, having the hair finished in a surprising manner. Also several little figures of metal; a sistrum very neat and well preserved; and not a day passes but they bring some curiosities newly found.

April 27, 1754. The place where they are digging at present, is under Il Bosco di Sant' Agostino, but a little distant from the royal palace at Portici. Its depth is one hundred and twenty-five Neapolitan palms †, one of which is more than the mercantile canna of Rome. All the buildings discovered in this site are noble: many of the pavements are of mosaic, variously and finely made; others are of different-coloured marbles, disposed with a beautiful symmetry; and most of them are already taken up. In one of these buildings there has been found an entire library, composed of volumes of the Egyptian papyrus, of which two hundred and fifty have been taken out; and the place is not yet cleared or emptied, it having been deemed necessary to erect props first, to keep the earth, which lies above it, from falling in upon it. These volumes of papyrus consist of Latin and Greek manuscripts; but from their brittleness, occasioned by the fire and time, it is not possible to unroll them, being now decayed and rotten. There have been found some of those small tables, which they covered with wax and the

* Since this was written some successful attempts have been made to unravel these ancient manuscripts, which treat of philosophy, music, &c.

† The Neapolitan palm is calculated at $11\frac{3}{8}$ inches English.—Orig.

palimpseston, and then wrote on them with the stylus: but all these are become a kind of cinder; and have also suffered by the damps; from both which circumstances they are now so tender, that they break with the touch.

In the same place there have been found three small busts; one of Epicurus, another of Zeno, and the third of Humachus; with the names of each inscribed on the basis, in Greek letters. A little distant from the preceding site has been discovered another noble building, with a square court belonging to it; the inside of which alone has been hitherto examined. This square is formed with fluted columns made of brick stuccoed. In the angles were four terms of marble, with busts on them, in bronze, of the finest manner, having the name of the Greek workman on one of them. In the centre, between the terms, was a small fountain, formed by a vase shaped like a cockle-shell, and supported by a small fluted column. There have been also found three other busts, large, and in bronze, likewise of the most excellent workmanship. Within these few days the following things have been taken out of the same site; viz. a female statue, six palms high, perhaps a goddess, though without any attribute, and but of middling workmanship; two most beautiful candlesticks, six palms and a half high, exquisitely wrought in chased work; other candlesticks, much damaged by the fire and time; many fragments in bronze, which, not having any particular merit, it is needless to describe, except two small figures of fawns, that are finely executed. In the same place was discovered a large fountain, lined throughout with lead: round it were eleven heads of lionesses, out of which the water flowed. Pipes of lead are very often met with; and scarcely a day passes but something is brought.

October 18, 1754. The first thing here discovered was a garden, in which were found several marble statues of excellent Greek artists. This route led towards a palace, which lay near a garden. But before arriving at the palace, they came to a long square, which formed a kind of forum, and was adorned throughout with columns of stucco; in the middle of which was a bath. At the several angles of the square was a terminus of marble, and on every one of those stood a bust of bronze, of Greek workmanship, one of which had on it the name of the artist, ΑΠΟΛΛΩΝΙΟΣ ΑΡΧ ΟΥ ΑΘΗΝΑΙΟΣ. A small fountain was placed before each terminus, which was constructed in the following manner: level with the pavement was a vase to receive

the water, which fell from above; in the middle of this vase was a stand of balustrade work, to support another marble vase. This second vase was square on the outside, and circular within, where it had the appearance of a scallop-shell; in its centre was the spout, which threw up the water, that was supplied by leaden pipes inclosed within the balustrades. Among the columns, which adorned the bath, were alternately placed a statue of bronze, and a bust of the same metal, at the equal distance of a certain number of palms. Seven statues were taken out from April 15 to September 30, near the height of six Neapolitan palms, except one of them, which is much larger, and of an excellent expression. This represents a Faun lying down, which appears to be drunk, resting on the goat-skin, in which they anciently put wine. Two other of these statues are of young men, and three of nymphs, all of middling workmanship. September 27, I went myself to take out a head in bronze, which proved to be that of Seneca, and the finest that has hitherto appeared, being as excellent a performance as can well be conceived. Our greatest hopes are from the palace itself, which is of a very large extent. As yet we have only entered into one room, the floor of which is formed of mosaic work, not inelegant. It appears to have been a library, adorned with presses, inlaid with different sorts of wood, disposed in rows; at the top of which were cornices, as in our own times. I was buried in this spot more than twelve days, to carry off the volumes found there; many of which were so perished, that it was impossible to remove them. Those, which I took away, amounted to the number of three hundred and thirty-seven, all of them at present incapable of being opened. These are all written in Greek characters. While I was busy in this work, I observed a large bundle, which, from the size, I imagined must contain more than a single volume. I tried with the utmost care to get it out, but could not, from the damp and weight of it. However, I perceived that it consisted of about eighteen volumes, each of which was in length a palm and three Neapolitan inches; being the longest hitherto discovered. They were wrapped about with the bark of a tree, and covered at each end with a piece of wood. All these were written in Latin, as appears by a few words, which broke off from them. I was in hopes to have got something out of them, but they are in a worse condition than the Greek. From the latter the public will see some entire columns, having myself had the good fortune to

extract two, and many other fine fragments. Of all these an account has drawn up, and published together with other Greek characters, on copper-plates. At present the monk, who was sent for from Rome, to try to open the former manuscripts, has begun to give us some hopes in respect to one of them. Those which I have opened, are philosophical tracts, the subject of which are known to me; but I am not at liberty to be more explicit.

Jan. 1755. Near the royal palace at Portici, has been discovered a large garden, with a palace belonging to it. In one room of this palace was found a mosaic pavement, made up of different coloured stones. It represents a city surrounded with walls, having four towers, one at each corner; and has since been taken up, to be placed with other beautiful antique pavements in the king's gallery.

Extract of a Letter from Camillo Paderni, dated at Naples, Jan. 1755.

October 22, 1754, was found a bust in bronze, larger than life, and of excellent Greek workmanship; which, from some circumstances, may be thought to be a Syrian king. It has eyes of white marble, like many other busts which have been met with. November 27, was discovered the figure of an old Faun, or rather a Silenus, represented as sitting on a bank; with a tyger lying on his left side, on which his hand rested. Both these figures served to adorn a fountain, and from the mouth of the tyger had flowed the water. This Silenus was of bronze, and of good workmanship. The head was crowned with ivy, the body all over hairy, and the thighs covered with a drapery.

From the same spot were taken out, November 29, three little boys of bronze, of a good manner. Two of these are young fawns, having the horns and ears of a goat. They have silver eyes, and each a goat-shin on his shoulder, in which they anciently put wine, and through which here the water issued. The third boy is also of bronze, has silver eyes, is of the same size with the two former, and in a standing posture like them, but is not a Faun. On one side of this last stood a small column, on the top of which was a comic mask, that served as a capital to it, and discharged water from its mouth. All the figures before described are two palms in height without their bases

December 16, in the same place were discovered another boy,

with another mask, and three other Fauns; in all respects like those which were found the 27th and 29th of November, except that there was no tyger. Besides these, they met with two little boys in bronze, somewhat less than the former. These likewise were in a standing posture, had silver eyes, and held each of them a vase, with handles, on his shoulder; hence the water flowed. They also dug out an old Faun, crowned with ivy, having a long beard, a hairy body, and sandals on his feet. He sat astride on a large goat-skin, holding it at the feet with both his hands, from which had issued a larger quantity of water than from the others; though the Faun himself is of the same size with the former.

All the above-mentioned figures were taken out of a place not exceeding eight palms square, and were covered with the ruins of the building; for they were not in a garden, but in a room paved with mosaic work, the remaining part of which we are now going on to examine. We have likewise found a large quantity of household furniture, made of earthen and iron ware, and some glass.

December 16, 1756. Two volumes of the ancient papyrus have been unrolled. One treats of rhetoric, the other on music; and both are written by the same author, Philodemus. Il Signor Canonico Mazzocchi, a very learned gentleman of this city, is now translating them from the Greek. There are two persons constantly employed in unrolling other volumes.

In the month of April were found two fine busts of women, the subjects unknown. Also a young stag, of excellent workmanship, on a base, The height of it, from the feet to the top of the head, is three palms and a half. Likewise its companion, but broken in many pieces. In May, a small young hog. In October, a female statue, of middling workmanship. Also a Silenus, a palm and three inches high, standing on a square base, raised on three rows of steps, supported at the angles by lions' claws. He has a bald head, a long curled beard, a hairy body, and naked feet. The drapery about him is loose and flowing: the fore finger of each hand is extended, and all the rest are closed. From his back arises a branch above the head, where it divides into two, which, twisting their foliage round it, fall and spread themselves below the shoulders, on each of which a stand is placed to fix a lamp. In the middle, between the extremities of these two small branches, is a bird resembling a parroquet. The whole of this figure is in a very good taste. All these things

above-mentioned, are of bronze. In November was discovered a beautiful marble Terminus, of Greek workmanship, as large as the life. It is dressed in a chlamys, has a young countenance, and the head is covered with a Grecian helmet. Many other things have also been found; as lamps, vases, and such-like, in bronze. And we have often met with paintings.

Feb. 1, 1758. Having been working continually at Herculaneum, Pompeii, and Stabiæ, since his communication of December 16, 1756, the most remarkable discoveries made there are the following:

February 1757, was found a small and most beautiful figure of a naked Venus in bronze, the height of which is six Neapolitan inches. She has silver eyes, bracelets of gold on her arms, and chains of the same metal above her feet; and appears in the attitude of loosening one of her sandals. The base is of bronze inlaid with foliage of silver, on one side of which is placed a dolphin.

In July was found an inscription, about twelve Neapolitan palms in length, as follows:

IMP , CAESAR , VESPASIANVS , AVG , PONTIF , MAX
TRIB , POT , VII · IMP · XVII · P · P · COS · VII · DESIGN · VIII
TEMPLVM , MATRIS , DEVM , TERRAE , MOTV , CONLAPSVM , RESTITVIT

After having found a great number of volumes of papyrus in Herculaneum; many pugillaries, styles, and stands with ink in them; at length, in the month of August, on opening a small box, was also found the instrument with which they used to write their manuscripts. It is made of wood, of an oblong form, but petrified, and broken into two pieces. There is no slit in it, that being unnecessary, as the ancients did not join their letters in the manner we do, but wrote them separate.

In September were discovered eight marble busts, in the form of termini. One of these represents Vitellius, another Archimedes; and both are of the finest workmanship. The following characters in a black tint, are still legible on the latter, namely APXIMΔΞ which is all the inscription that now remains. In October was dug up a curious bust of a young person, who has a helmet on his head adorned with a civic crown, and cheek-pieces fastened under his chin. Also another very fine bust of a philosopher with a beard, and short thick hair, having a slight drapery on his left shoulder. Likewise two

female busts; one unknown, in a veil; the other Minerva, with a helmet; both of middling workmanship. In November we met with two busts of philosophers of excellent workmanship, and, as may be easily perceived, of the same artist; but unfortunately, like many others, without names. In January was found a small but most beautiful eagle, in bronze. It has silver eyes, perches on a præfericulum, and holds a Faun between its talons. In the same month was discovered at Stabiæ, a terminus six palms high, on which is a head of Plato, in the finest preservation, and performed in a very masterly manner. Also divers vases, instruments for sacrificing, scales, balances, weights, and other implements for domestic uses, all in bronze.

Having finished the examination and arrangement of the scales, balances, and weights, which were very numerous in the museum; it was remarkable that many of the former, with all the weights, exactly answer those now in use at Naples.

To this full account of the antiquities discovered at Herculaneum, we shall only add the following entertaining description of the general appearance of the city, and the entrance into it; and of the great pains and dexterity evinced in unfolding the scorched rolls of papyrus.

The entrance into Herculaneum is described to be down a narrow passage, cut with a gradual descent; and towards the bottom into steps, and the city is supposed to lie about sixty feet under the surface of the ground. Those who go down into it, carry each of them a wax taper, and are preceded by a guide. It is supposed that besides the earthquake, which swallowed up this town, it was also at the same time overwhelmed with the burning lava, which ran down from mount Vesuvius, during the eruption. And accordingly all the passages into it are cut through this lava; which is a very hard substance, like stone, of a slate colour, and said to be composed of various kinds of metals and glass; which, indeed, is manifest in the appearance of it. The streets of Naples are paved with the same lava; but it it seems to be of a much more soft and sandy substance in Herculaneum, than in the place where they dig it for use.

The appearance of this city would greatly disappoint such, as should have raised their expectation to see in it spacious streets and fronts of houses; for they would find nothing but long narrow passages, just high enough to walk upright in, with a basket on the

head; and wide enough for the workmen, who carry them, to pass each other, with the dirt they dig out. There is a vast number of these passages, cut one out of another; so that one might perhaps walk the space or two miles, by going up every turning.

Their method of digging is this: whenever they find a wall, they clear a passage along the side of it. When they come to an angle, they turn with it; and when they come to a door or a window, they make their way into it. But when they have so done, they are far from finding themselves in a spacious room, or open area; for all the rooms and places they have yet found, are so filled with lava, that it sticks on to the sides of the walls; and they can advance no farther than as they can make their way by digging: which is such labour, that when they cease to find any thing worth their search, they fill up the place again, and begin to dig elsewhere. By which means no place is quite cleared. Consequently it does not appear how many stories high the houses may be; nor is any thing to be seen over head but lava. In this are vast number of burnt beams, that seem to have been joists of floors, though they are now little more than black dust; and where they are quite mouldered away, one may plainly see the grain of the wood imprinted on the lava, so close did it stick.

A skeleton was found in a door-way, in a running attitude, with one arm extended, which appeared to have had a bag of money in the hand of it, for the lava had taken so exact an impression of the man, that there was a hole under the hand of the extended arm; which hole was apparently the impression of the bag, and several pieces of silver coin were found in it. This man therefore must have had notice enough of the danger, to endeavour to secure his treasure; though he must have been instantaneously encompassed with liquid fire in attempting it. No manuscripts have yet been found; but they have met with some few inscriptions on marble, but none of any consequence, or which serve to give new light on any point of antiquity.

The writer proceeds next to give some account of the paintings, and observes that, much the greatest part of them are little better than what you will see on an alehouse wall. They are all painted on plaster, which has been very carefully separated from the wall, in as large pieces as possible. These pieces are now framed, and there are above 1500 of them, but not above twenty that are to-

lerable. The best of them are three large pieces; one of which is a sort of history piece, containing four figures, with some expression in their faces; but even these best, if they were modern performances, would hardly be thought worthy of a place in a garret. There are about a dozen little pieces, of women dancing, centaurs, &c. the attitudes of which are very genteel, and the drawing pretty, but the shading is mere daubing.

The colouring is allowed to be surprisingly fresh and well preserved, considering how long it has been done, but the painters seem to have been masters of only a few simple colours, and those not very good. The red is the brightest and best. The lava was found sticking to all the painting; which, some think, has helped to preserve it. The paint is liable to be rubbed off; to prevent which inconvenience, they have slightly varnished it.

The designs of the greatest part of these paintings are so strange and uncouth, that it is almost impossible to guess what was aimed at. Much of it looks like such Chinese borders and ornaments as we see painted on skreens. There are numbers of little figures dancing on ropes; a few small bad landscapes; and some very odd pieces, either emblematical, or perhaps only the painter's whim. Of which last the writer gives two specimens; one, of a grasshopper driving a parrot; the other, of a vast great head, in the midst of what seems to have been intended for a green field encompassed with a hedge.

The theatre is a conspicuous object; and it is thus described by Mr. Freeman. The building is in the form of a horse-shoe. That part where the spectators sat, is visible, and consists of eighteen rows of broad stone seats, one above another, in a semicircular form. At proper distances within the circuit of the seats, through the whole range, from bottom to top, are little narrow flights of steps, by which the spectators might come to, or go from, their seats commodiously, without crouding. These steps or stairs also lead up, in a straight line, to a sort of gallery, several feet wide, which ranges all round the outside of the theatre, and is called the precinct; above which there are other stairs, which lead to a second. By this precinct it is judged, that the theatre, with the orchestra, must be about fifty-two or fifty-three feet diameter.

Going round the theatre, are seen several large square pilasters, equally distant from each other; and which supported the whole edi-

fice. These pilasters are of a thin compact red brick, adorned with marble cornices. The pavement of this theatre must have been very beautiful, by the different coloured marble, that has been taken out of it, and some that remain. In short, by the broken pieces of cornices, mouldings, and carved work, and the many fragments of pillars, &c. which have been found within and without the theatre, it appears to have been a most magnificent edifice.

There are two principal gates to the theatre, with inscriptions on the architraves, which are taken out, and placed in the king's palace, among the other curiosities

There is another opening, distant from that which leads to the theatre, by which they have made a way into some houses. Here they seem to have dug infinitely more than about the theatre; for one may ramble, as in a labyrinth, for at least half a mile. Among the things that have been dug out of either of the two places, are many parts of broken horses, with part of a triumphal car or chariot, all of gilt bronze; and which, they say, was placed over one of the gates of the theatre. Two equestrian statues, which were found on each side of one of the said gates, and they suppose fronting a street that led to the theatre. Those, they say, were erected in honour of the two Balbi, father and son, who were benefactors to the Herculaneans. One of these statues cannot be repaired; the other, which happened to be better preserved, is well repaired, and is set up under the piazza in the gateway of the king's palace at Portici.

This is a most beautiful statue, and is considered to be one of the best in the world. Not far from it at the bottom of the palace stair-case, are fixed a beautiful statue of the emperor Vitellius, very perfect and entire; one of Nero, with a thunderbolt in his hand; one of Vespasian; one of Claudius; one of Germanicus; and two beautiful statues, sitting. There are many others, of marble, and of bronze, all larger than life; and even some gigantic, or colossal; many without heads, or arms, and others so d stroyed as never to be repaired. Of busts, there are some very beautiful, as that of Jupiter Ammon, Neptune, Mercury, Juno, Ceres, Pallas, &c. In the apartments of the palace is a vast number of little statues, many of which are extremely beautiful: also a great number of little idols, tripods, lachrymatories, and many vases curiously wrought. Among these is a whole loaf of bread burnt to a coal, which they will not suffer any one to touch. It is covered with a glass bell, through

which are perceived letters on the loaf, which possibly were the baker's mark.

There are many other valuable curiosities locked up in the king's closet and private apartments; such as medals, intaglios, and cameos.

Of the pictures, some were taken out of a temple near the theatre, others from the houses. They have all preserved their colours to admiration, which are very lively. They are painted in fresco, and were sawed out of the walls, with much trouble and care; and are now fixed, with binding mortar, or cement, in shallow wooden cases, to prevent their breaking, and varnished over, to preserve their colours. You must think, that these pictures are not alike valuable, otherwise than from their antiquity; some doubtless have been done by good hands, others by bad, as one sees by the works of those now-a-days. There are two as large as life. One of these pictures, they say, represents Theseus. The figure is naked, and holds a small club in his hand: between his legs lies a Minotaur, the posture of which produces a most admirable foreshortening. There stand about him also three little boys, one of which kisses his right hand, another embraces his left arm, and the third his left hand; all extremely well expressed. The other picture is of the same size as the former, and composed of many figures as large as life. A woman sitting with a wand in her hand, and crowned with flowers; on one side of her stands a basket of pomegranates, grapes, and other fruit; near her is a little satyr or fawn, playing on one of the ancient instruments, of six or eight tubes, joined together in a row. There is a lusty naked man standing by her, with his face turned somewhat towards her, with a short black beard. He has a bow, a quiver of arrows, and a club. In the same piece is another woman, who appears talking to the first; she is crowned with ears of corn. There is also a hind giving suck to a boy, which they say represents the story of the discovery of Telephus. Another picture represents a winged Mercury, with a child sitting across his neck, near whom is a woman sitting, and taking Mercury by the hand. This, we are told, was supposed to be Bacchus carried to nurse. Another piece represented Jupiter embracing Ganymede. In another is a hunt of stags and swans. Three others, in each a Medusa's head. Another, representing two heads of imaginary animals. A beautiful one, representing two of the Muses, one playing on the

lyre, the other with a mask on her head; another, with a lion, a wood, and distant views. In another, various centaurs, buildings, &c. In another, a stag; over which is a bird flying, and seeming to beak at him. Two other small pictures of a dolphin. Another with architecture, and distant views. One with a peacock. Another with a temple, adorned with various pillars.

There have been found also two cornucopias of bronze gilt, a large round shield of metal, two metal dishes, several lachrymatories of glass, others of earth; four large candlesticks of bronze, a large metal vase with a handle; many others of earth, curiously wrought; the foot of a lion most curious, but in marble, and which supported a marble table; a beautiful mascharron of metal, having the face of a cat, with a mouse in her mouth. There is also a very fine medallion, extremely well preserved, with a bas relief on both sides; on one is a woman, near whom is a man naked killing a hog; on the reverse is an old man, naked to his waist, sitting and playing on two pipes, which he holds in his hands. There is another odd piece in bas relief, which represents a green parrot, drawn in a chariot, and driven by a green grasshopper, which sits on the box, as coachman. There are many baskets and cases full of different things, all jumbled together; such as kitchen utensils, locks, bolts, rings, hinges, and all of brass. Things, that were of iron, were totally eaten up with rust. When the workmen came to any thing of that sort, it mouldered to dust as soon as they touched it; occasioned doubtless by the dampness of the earth, and the many ages during which it lay buried. There were found many vases, and crystal bottles full of water; but that might penetrate through the earth, and fall into them, if not close stopped: also a sort of standish, or inkhorn, in which were found many stylets, or pens, with which they wrote in those days. When it was first taken out, they say the ink had not only its natural colour, but that it was yet capable of tinging: it is very dry now. There were eggs found quite whole, but empty; also nuts and almonds; grain of several sorts, beans and pease, burnt quite black. Many other sorts of fruit were found burnt quite to a coal, but whole and entire.

Mr. F. declares that he cannot be of the opinion of some, who assert that this city was suddenly swallowed up, which implies that the earth must have opened, and formed a pit to receive it. His opinion is, that it was overwhelmed with the boiling matter issuing

from the mountain, at the time of the eruption; because most things were found upright, chiefly the buildings. That it was not a sudden overwhelming, and that the inhabitants had time to escape with their lives, though not with their goods, is proved, by their not finding dead bodies, where they have hitherto dug. It is said that some human bones were found, though very few. Very little money or plate has been found, or any other portable thing of great value; which is another proof that the inhabitants were not destroyed. Doubtless before the violent eruption came on, the people for some days might perceive such tokens and signs, as could not but alarm them, and put them on their guard; as at the eruption which happened in 1737, before it burst forth for some days, the inhabitants of Portici, and the adjacent villages, all retired: being by some signs apprised of the event.

The matter (called the lava) it seems is not of the same quality nor substance all the way through the body of it; for in descending to the theatre, the sides of the passage at the entrance were a sort of mold, eight or ten feet thick; after which appeared stone of a blackish or dark grey colour, to the thickness of about three or four feet; then another layer of sandy earth, under which was a layer of the same sort of stone; and thus it continues stratum super stratum, to the bottom. The theatre and the houses seem all to have been filled with earth. In general, this stone is very hard and heavy, and the whole city of Naples is paved with it. Some of it will bear a fine polish, and of which they make snuff-boxes.

With respect to the delicate means employed for unrolling the scorched papyrus, we are told that a great part of these rolls were found in the chamber of a house, or, more properly speaking, of an ancient villa, in the middle of a garden, about a palm long, and appeared like roots of wood, all black, and seeming to be only of one piece. One of them falling on the ground, it broke in the middle, and many letters were observed, by which it was first known, that the rolls were of papyrus. The number of these rolls were about one hundred and fifty, of different sizes. They were in wooden cases, which are so much burnt, as are all the things made of wood, that they cannot be recovered. The rolls, however, are hard, though each appears like one piece. The king has caused infinite pains to be taken to unroll them, and read them; but all attempts were in vain: only by slitting some of them, some words were observed.

At length, Sig. Assemani, being come a second time to Naples, proposed to the king to send for one Father Antonio, a writer at the Vatican, as the only man in the world who could undertake this difficult affair. It is incredible to imagine what this man contrived and executed. He made a machine, with which, by the means of certain threads, which being gummed, stuck to the back part of the papyrus, where there was no writing, he begins, by degrees, to pull, while with a sort of engraver's instrument he loosens one leaf from the other, which is the most difficult part of all, and then makes a sort of lining to the back of the papyrus, with exceedingly thin leaves of onion, if I mistake not, and with some spirituous liquor, with which he wets the papyrus, by little and little as he unfolds it. All this labour cannot be well comprehended without seeing. With patience superior to what a man can imagine, this good father has unrolled a pretty large piece of papyrus, the worst preserved, by way of trial. It is found to be the work of a Greek writer, and is a small philosophic tract, in Plutarch's manner, on music; blaming it as pernicious to society, and productive of softness and effeminacy. It does not discourse on the art of music. The beginning is wanting, but it is to be hoped, that the author's name may be found at the end; it seems, however, to be the work of a stoic philosopher; because Zeno is much commended. The papyrus is written across in so many columns, every one of about twenty lines, and every line is the third of a palm long. Between column and column is a void space of more than an inch. There are now unrolled about thirty columns; which is about half of the whole; this roll being one of the smallest; the letters are distinguishable enough. Father Antonio, after he has loosened a piece, takes it off where there are no letters; and places it between two crystals for the better observation; and then, having an admirable talent in imitating characters, he copies it with all the lacunæ, which are very numerous in this scorched papyrus, and gives this copy to the Canon Mazzocchi, who tries to supply the loss and explain it. The letters are capital ones, and almost without any abbreviation. The worst is, the work takes up so much time, that a small quantity of writing requires five or six days to unroll, so that a whole year is already consumed about half this roll. The lacunæ, for the most part, are of one or two words, that may be supplied by the context. As soon as this roll is finished,

they will begin a Latin one. There are some so voluminous, and the papyrus so fine, that unrolled they would take up a hundred palms space.

[*Phil. Trans. Abr. X.*]

5. *Ruins of Pompeii.*

We have already observed *, that the volcano, that, with its disembowelled contents, overwhelmed Herculaneum, destroyed and buried Pompeii in like manner. Its site having been pointed out by the discovery of Herculaneum, various successful attempts were made about the same time to obtain a knowledge of its ruins; and the following letters from Signor Paderni, and published like the preceding in the Philosophical Transactions, give an interesting account of them.

In April last, a little beyond La Torre della Nunziata, where stood the ancient Pompeii, in digging near the amphitheatre, there was discovered a marble capital of the Corinthian order. On making further trials, there were found two pilasters of white marble, about ten feet high, fluted on every side, with capitals and bases of the Corinthian order. On one side of these pilasters have been found a series of nine other pilasters, about seven feet high, equally wrought with the larger: there were likewise five other pilasters on the side of the other great one, making in all sixteen; which are all of one piece, exclusive of the capital and the base, except one, which is composed of two pieces. They were all excellently preserved, and were standing; forming a portico before a building. All the buildings, which are in Pompeii, are of the same constitution with those of Herculaneum and Strabiæ; that is, of one story. The portico is continued on the sides, but the pilasters are not of marble, but of brick covered with stucco, and coloured with green, and are not fluted like those of marble. One only of the sides is yet undiscovered, and we must wait to see the side opposite to the front, and the rooms within, to be able to speak decisively,

The front was all painted in the grotesque manner; but little, and that ill preserved, remains. There were no ornaments of stucco, or marble; the walls indeed were coloured, and there were some small niches formed in the walls, each of which corresponded to one

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* See Book II. Chapter IX. Sect. i.

of the pilasters, and consequently there were eighteen in number. In several of them were found certain figures, some of earth, others of marble, in this order; first was placed one of marble, then one of earth: those of marble were nine small Hermæ, among which there is a Hercules crowned with oak, some Satyrs, Fauns, and Bacchantes. Two of them are of the old red, and the other of the old yellow marble, and are of an indifferent style. Those of the baked earth consist of four figures. The first is a Barbarian king, who stands erect with his right hand under his chin in a pensive manner, and wears his chlamys clasped with a fibula on his right shoulder. But what makes this figure the more curious is, that the whole body forms a vase, on the back of which there is a handle to hold it by. Behind the head there is a little tube, through which water or some other liquor was poured in, and the mouth of the figure is open, through which the liquor was poured out. The height of it is about ten inches, and the style rather low.

The second figure is of the same height and character, as to the workmanship; but what it represents, renders it singular. This figure seems sitting, with its legs stretched out, which are distorted like those of some dwarfs. It has a great head; the mouth, eyes, and nose of which are extremely overcharged. It is dressed in the prætexta. On the breast is the bulla aurea, the string of which surrounds its neck, and is held with the right hand; with the left it holds the tablettes called pugillares, on which the ancients placed wax, and wrote on it with a style. These pugillares are exactly like those dug up at Herculaneum, and which are preserved in that museum. Besides, it bears a great priapus, and behind is seen the breech. This was made for a vessel, such as that described above, except that besides that the mouth of this figure is pierced, the liquor can also be poured from the priapus.

The third figure is entirely like the preceding, except in its dress, which is rustic, and bound round the waist with a cord, to which is fastened somewhat that cannot be made out, but which appears to be a little case to hold something: the rest is not overcharged, but is rustic. It holds in its right hand a loaf, and its left hand is covered with its dress, and, like the other, it shows its breech and priapus. Probably such vessels were used for drinking the liquor coming out of the priapus, this being not unusual with the ancients, as Juvenal,

in his second satire, gives us to understand:—"Vitreo bibit ille priapo."

The last figure represents the Roman Charity. She is sitting, and with her left hand embraces her father, and with her right presses the breast which her father sucks; who is expressed in this figure totally emaciated. This does not, like the others, form a vessel, but simply exhibits the story. The style is moderate, its height near the same as that of the others. This last groupe is covered with a varnish of glazing, like that which covers earthen plates and things of that kind. There were found, in the before-mentioned niches, two little busts of baked earth, of the same height; one wants the head. This is all that is found in that part of the building, which is supposed to be the front.

In a little closet, the dimensions of which are about six feet in length, and four in breadth, was found a very fine tripod, about three feet high, extremely well preserved. In short, it is one of the most beautiful pieces of antiquity in the whole world. It is formed of three satyrs, young, and all exactly alike. Their heads are most beautiful, with a cheerful countenance, and a hair well disposed with a ribband, that surrounds the head. On the forehead stand two small horns, which are united. The right hand rests on the side of the body, and the left is open, with the arm somewhat extended. They have a great satyresque priapus. The legs are united, and they place their feet on round bases, which have been turned in a lathe, and then covered with leaf silver. Their tails are twisted round a ring, by which they are suspended. The three satyrs support with their heads the hearth of the tripod, which is of excellent workmanship, and has three moveable rings, which serve to remove the tripod from one place to another. One of these rings is wanting, and could not possibly be found: whence we may suppose, that originally it was likewise wanting. On the hearth is another ornament united to its circumference, and forming a kind of radiated crown, which crown has also two handles, but not moveable: these serve to place the crown on the hearth. The bottom of the hearth is not of brass, like the rest of the tripod, but of baked earth. The above-mentioned closet, where this tripod was found, is all painted, and entire, with the ceiling unhurt. In the walls of it was a table of white marble,

fastened in the wall itself, which might be called a side-board, and which was extended along the sweep of the room. On this table was found a crescent of silver, about five inches in diameter, and on the edge of its middle are two small holes to receive a string to support it. Perhaps this was an amulet, for we have another of the same metal, but smaller, with its supporter of silver, which has been long found. On the same table was another amulet of silver, about an inch in height, which represents Harpocrates. This figure has its finger near its mouth, the lotus on its head, and wings on its shoulders. On the right shoulder hangs a quiver, and its left arm holds a horn of plenty, and leans on the trunk of a tree, round which is a serpent, and at the foot of the trunk stands an owl. There was found a kind of fibula, which is of gold, and is extremely well preserved. Its form is round, and made like a large button. On the back there is a gold wire fastened to one side; the other end of which is fastened in a small piece of gold, soldered into the fibula. The whole is little more than an inch in diameter. There were found also two other figures; one is of marble, about a foot high, representing a woman; it is of no great value; the other is of ivory, but there remains nothing but the name, and a part of the face, by which may be perceived, that it is the work of an excellent Greek hand. All the rest consists as it were of minute leaves, which are so brittle that they cannot be united. Its height is about a foot.

There was also found in the same closet, on the same marble table, one of the most beautiful statues ever seen, and so admirable, that I know not how to begin to describe it. Its height is little more than three inches, by which you may conceive what pains may have been taken with it. It stands on its feet, and is quite naked, and presents a priapus, which is not satyresque, with a most perfect contrast of attitude. One observes through the whole figure a most perfect skill in anatomy, where the smallest muscle is not lost, and at the same time it seems not dry or hard, but palpable flesh. It is of a noble and excellent stile. Its head is somewhat rustic, with a goat's beard and ears. It has a laughing countenance, turning its head with much grace, and brings its first finger of the left hand to its face. It extends and raises its right arm, which terminates in a manus impudica. Our Neapolitans, and I have seen the same in our peasants about Rome, frequently wear in their hair a pin, the head of which consists of such a hand; and they say, that they wear

this against an evil eye; and in Naples some of these pins are worn by children. We have found several of these small hands at Herculaneum. It is observable, that these Priapi frequently had this hand; for among the many which remain under my care, there is one with human ears, and with this hand, which together with the whole arm, forms a priapus. The head of the figure is covered with a cap, which is folded down behind; and its base is low and round, and well fitted. In fine, this may be called one of the most excellent curiosities. In one of the other rooms there was a fine pair of scales, in which there are some remains of the strings made of a kind of fine coral, and the strings remain in some of the rings. There were found also many vessels of earth and fragments of metals.

In the ancient Stabiæ they go on digging; but it is long since any thing of value has been found there, except that two small statues of brass have been lately discovered. One represents a Venus, but of no value. The other a Panthea with a rudder, horn of plenty, lotus, modius, and sickle: it is but of ordinary workmanship. Many vases of earth, some of glass, have been found. A great vessel of copper with a handle, a singular funnel, a beautiful little vase of rock crystal with its cover, and a simpulum or ewer; divers medals, as well silver as copper, well preserved, but common, and various pieces of leaden pipes, have also been found there.

The same may be said of Herculaneum; for since the colossal bust of brass has been found, they have discovered nothing of value, except one thing, which ought to make much noise among the learned, and which I believe to be the only one of its kind in the world. This is a little leg and thigh of metal covered with silver, and which is five inches long. On the external part of it is described a sun-dial formed on a quadrant, and as the thigh forms a quarter of a circle, the workman has taken the centre of this quadrant from the extremity or leg of the ham or gammon, and hence has drawn hour lines, which, with the lines that mark the months, form the usual compartments, some larger and others smaller, which are divided 6 by 6, as well in height as length. Below the inferior compartments, which are the less, are read the names of the months placed in 2 lines in a retrogade order, so that the month of January is the last in the first line, which bears the other

fivefollowing months. In the 2d line are described the 6 other months in their natural order; so that the month of December is under January, and so the months shorter and longer, 2 and 2, have one common compartment for each couple. Almost on the edge of the right side, there is the tail of the animal somewhat bent, and this performs the office of the gnomon. On the extremity of the bone, that is, of the leg, or centre of the quadrant, there is a ring to hold the dial in an equipoise; and it is supposed that in that place was fastened its plummet, such as in the like dials is to fall on the present month, to determine the shadow of the gnomon on the horary lines. It is observable also, that as these dials were described on a plain surface, according to a fixed rule, the surface of this metal ham being in one plane concave, in another convex, one cannot easily guess what rule the workmen used to describe a dial of so difficult a kind, on a surface so irregular.

I must not neglect to acquaint you with what has been found in a trial made at Cuma, where were situated some sepulchres, which afforded many curious things. In May last, our miners opened a tomb of the family Pavilia, which formed a small chamber. On the floor were 3 corses, or rather their bones, which were included in 4 pieces of the piperine stone. These 4 stones formed for each corse an oblong case. The engineer, who was present at the discovery, told me, that one of these bodies was all covered by a substance unknown to him; but from his account I comprehended what it was. The corse was covered with a cloth of amianthus, which, as it was large, remained in this situation all on a heap, but calcined by the salts of the earth, for which reason it was necessary to take it up in pieces, it being become extremely brittle. However, to be more sure of my opinion, I had a mind to try it in the fire, where it remained unchanged; whence there is no doubt but that it is amianthus. There were found a great many little pieces of paste as large as beans, which were taken by the miners for comfits, but are the confection which used to be put on dead bodies. They are composed of myrrh and other spices, and even now retain a very strong smell. There was found some cloth reduced almost to nothing, which had some ornament of gold embroidered on it, or rather wove into it, as is more probable from the gold thread. On the above-mentioned body were found some pieces of paper, for I have great reason to think it such from the trials, which I have made on the old papyrus,

of which we have about 800 volumes. This paper on one side is coloured with red minium, on the other it is black.

Besides this paper, there were found a mirror of metal, and 3 tesseræ, or dice. Under the corse, or bones, was found a padlock, through which were passed 3 iron strigils, and another that was broken. It is remarkable, that in all the other sepulchres, that were opened at Cuma in the month of May, there were found a mirror, three tesseræ, strigils, and some very small fibulæ of bone. In the above-mentioned sepulchre was found a small lectisternium, or rather *pulvinar deorum*, which was very much decayed. It is mounted in iron. The ornaments which compose it being of ivory, the rust of the iron has as it were destroyed the whole. So that there were collected but a few remains of the 4 pillars, some pieces of the bands, which went round the frame, 8 pieces of ivory, of an oblong form, in each of which was engraved a figure of some unknown deity, all of the same design, but in a bad style; and two heads of a horse, which are fellows, and belong to the lectisternium, not unlike that great one of brass, which is now in the Royal Museum. There were found also several little vases of earthen ware, whose form is this: they have a long neck, with a mouth proportionably straight: the body is oval, which towards the bottom is so small, that they cannot stand upright. The misfortune is, that 2 of these vases, which are of oriental alabaster, and of the most excellent workmanship, are both broken in the middle.

Near this sepulchre there was opened another, belonging to the freed men of the Pavillia family. There we found many glasses and pieces of earthern ware, and two most beautiful earthern lamps. On one of them is a Hercules going to slay a serpent with his club, which he holds in his left hand. On the other is a priestess of Bacchus, which in one hand holds the sacrifical knife, and in the other the half of a victim. There are also 2 very small wine-glasses, which contain, the one a liquor of the colour of red wine, the other a liquor more limpid than white wine, but without any smell. In this tomb were found also the usual dice, strigils, mirrors and fibulæ. The bones and ashes were in urns made of earth.

Four other sepulchres also have been opened, in all of which were found the usual strigils, mirrors, tesseræ, and fibulæ. In one of them was found a little earthern urn with its cover. Within the same tomb was a small urn of glass elegantly made, containing the ashes

of a child. Near the said urn were found several little things, which probably were the playthings of the child; these were two very small goblets of baked earth glazed, with a handle to each; two small water ewers, of the same materials, with ornaments; these also are extremely small; another vase of common earth, which forms a recumbent ox, on the back of which is a hole to receive the water, which was poured out through the mouth; and there is a handle on one side of the body. In this same sepulchre was found a monstrous priapus of red earth. This figure has wings, and is much overcharged. All these things, which I have described, are preserved by me in the Royal Museum, in a separate apartment from that in which is preserved what has been found at Herculaneum, Pompeii, and Stabiæ. I have already filled 8 chambers with antiquities; and because those are not sufficient, I shall begin to place many other things, which hitherto I have been forced to keep in confusion in other chambers, which are on the same floor. A single volume of the Papyrus is unfolded, being that which treats of music. At length the name of the author, who was called Philodemus, is found written twice, at the end of the piece. The name is written once in a small, and a second time in a large hand, and in a good Greek character. They are now beginning to open, or rather to unroll another manuscript; but hitherto without much success; from some fragments we may collect that it treats of rhetoric.

Dr. Watson makes the following Observations on the preceding.

I think it probable, that Philodemus, the author of this treatise on music, was the Epicurean philosopher of that name, who was, as Strabo informs, a native of Gadara, in Syria. He wrote many pieces in prose and verse, and his 10th book, *περι των φιλοσοφων συνταξεως*, is quoted by Diogenes Laertius. Indeed his sect, time, and abode, will allow of the supposition of his writings on music being at Herculaneum at the time of its destruction. He resided at Rome, and was the acquaintance of Tully, and the preceptor of Lucius Piso, the consul. We learn from Ascanius Pedianus, that it is Philodemus the Epicurean, of whom Cicero speaks with that admirable mixture of praise, and invective and excuse, in his oration against Piso; where he says, that he knew him to be a man of elegance and polite literature; that it was from him that Piso learned his philosophy;

which was, that pleasure ought to be the end of all our pursuits; that indeed the philosopher did at first divide, and distinguish the sense in which that maxim was to be understood; but the young Roman perverted every thing to make it favour his inclinations and pleasures; and the Greek was too polite and well-bred to resist too obstinately a senator of Rome. He then tells us that Philodemus was highly accomplished in philosophy, as well as polite literature, which other Epicureans were apt to neglect; that he wrote verses, which were so sweet, so elegant, and so charming, that nothing could exceed them; that he was betrayed into a too hasty friendship with Piso, from which he could not disengage himself without the imputation of inconstancy, and that, "rogatus, invitatus, coactus, ita multa ad istum de isto scripsit, ut omnes libidines, omnia stupra, omnia cænarum conviviorumque genera, adulteria denique ejus, delicatissimis versibus expressit."

I have met with some epigrams of Philodemus yet extant, some of which are, in my opinion, most facetious and elegant. We might have had many more, had not Planudes, as the scholia inform us, rejected such out of his collection, as he thought too loose and voluptuous. Horace seems to have had some of these epigrams in his eye more than once, when he wrote his 2d satire of the first book; particularly where he says—

——— hanc Philodemus ait; sibi, quæ neque magno
Stet pretio, neque cunctetur, cum est jussa venire.

Is not this almost a translation of the

και παρεχουσα
Παντα, και αιτησαι πολλακι φειδομενη.

I will give the whole epigram, as a specimen of the style and manner of Philodemus; but must beg, that in reading the third verse you would recollect what Homer says of the girdle or cestus of Venus, that it contained all kind of delights and blandishments, love, persuasion, and desire.

Φιλοδημου επιγραμμα.
Μικκη και μελανευσα Φιλαινιον. αλλα σελινων
Ουλοτερη, κ' αμνου χρωτου τερεινοτερη,

Και κεστου φωνευσα μαγωτερα, και παρεχουσα
Παντα, και αιτησαι πολλακι φειδομενη.
Τοιαυτην στεργοιμι Φιλαινιον, αχρις αν ευρω
Αλλην, ω χρυσεη Κυπρι, τελειοτερην*.

Extract of the second Letter from Camillo Paderni, dated Naples, July 25, 1755.

A cameo of great excellence was found the 9th of this month. This cameo is in alto relievo. It is about an inch and a half long, and almost as much in breadth. It represents a half length of Ceres. The head is in profile, and has a noble and beautiful air. It is turned, together with the body, a little to the left. The left arm is a little raised, and holds in the hand some ears of corn. The right arm is lower, and close to the body. The right hand takes hold of part of a fine garment, or shift, with which the figure is in part covered. The head is adorned with a diadem; and the hair, which is of excellent workmanship, flows on her shoulders, tied with a single ribband, which rests on her neck. The stone, of which the head is composed, is pellucid, and the rest of the figure is cut out of a chalcedony by a Greek master; it was found at Stabiæ, where they continue to dig. In the same place were found also buried several vases of metal and glass, very well preserved.

At Pompeii within these few days was found a most beautiful wine-strainer, small, but finely pierced, in a better taste than those already found, which are of brass. In this same place was dug up an inkstandish, with some of the ink, which I likewise preserved. There has been met with also an iron ax. There have been found, and they go on daily to find, many pictures. If the ancients had not dug in this place, we should have discovered many more things; for we find that they have taken away even some of the pictures.

* Since the death of the learned Dr. Watson, which happened March 2, 1756, soon after his translation of these two letters of Camillo Paderni, and his observations on the former, were read at the Royal Society, another epigram of Philodemus has been transcribed, published at Leipsic in 1754, by the celebrated Mr. Reiske, which appears likewise to have been alluded to by Horace in the passage in part cited above from his second satire of the first book, ver. 120,—Orig.

6. *Subterranean Ruins at Civita Turchino, in Italy. By Joseph Wilcox, F.S.A.*

Civita Turchino, about three miles to the north of Corneto, is a hill of an oblong form, the summit of which is almost one continued plain. From the quantities of medals, intaglios, fragments of inscriptions, &c. that are occasionally found here, this is believed to be the very spot where the powerful and most ancient city of Tarquinii once stood; though at present it is only one continued field of corn. On the south-east side of it runs the ridge of a hill, which unites it to Corneto. This ridge is at least three or four miles in length, and almost entirely covered by several hundreds of artificial hillocks, called by the inhabitants Monti Rossi. About twelve of these hillocks have at different times been opened, and in every one of them have been found several subterranean apartments cut out of the solid rock. These apartments are of various forms and dimensions: some consist of a large outer room, and a small one within; others of a small room at the first entrance, and a larger one within; others are supported by a column of the solid rock, left in the centre, with openings on every part, from twenty to thirty feet. The entrance to them all is by a door of about five feet in height, by two feet and a half in breadth. Some of these have no other light but from the door, while others seem to have had a small light from above, through a hole of a pyramidical form. Many of these apartments have an elevated part that runs all round the wall, being a part of the rock left for that purpose. The moveables found in these apartments consist chiefly in Etruscan vases of various forms; in some indeed have been found some plain sarcophagi of stone with bones in them. The whole of these apartments are stuccoed, and ornamented in various manners: some indeed are plain, but others, particularly three, are richly adorned; having a double row of Etruscan inscriptions running round the upper parts of the walls, and under it a kind of freize of figures in painting: some have an ornament under the figures that seems to supply the place of an architrave. There have been no relievos in stucco hitherto discovered. The paintings seem to be in fresco, and are in general in the same stile as those usually seen on the Etruscan vases: though some of them are much superior perhaps to any thing as yet seen of the Etruscan art in painting. The paintings, though in ge-

neral slight, are well conceived, and prove that the artist was capable of producing things more studied and more finished : though in such a subterranean situation, almost void of light, where the delicacy of a finished work would have been in a great measure thrown away ; these artists (as the Romans did in their best ages, when employed in such sepulchral works) have in general contented themselves with slightly expressing their thoughts. But among the immense number of those subterranean apartments which are yet unopened, it is to all appearance very probable that many paintings and inscriptions, may be discovered, sufficient to form a very entertaining, and perhaps a very useful work: a work which would doubtless interest all the learned and curious world, not only as it may bring to light, if success attends this undertaking, many works of art, in times of such early and remote antiquity, but as perhaps it may also be the occasion of making some considerable discoveries in the history of a nation, in itself very great, though to the regret of all the learned world at present almost unknown. This great scene of antiquities is almost entirely unknown even in Rome. Mr. Jenkins, then resident at Rome, was the first and only Englishman who ever visited it.

[*Phil. Trans.* 1763.]

7. *Subterranean Ruins of the ancient city Industria. By David Erskine Baker, Esq.*

Dr. Joseph Laurentius Bruni, F. R. S. and physician of the College at Turin, having, in the month of March, 1744-5, sent from thence the description of a most curious antique tripod of metal, found, some little while before, together with a plate of the same, bearing an extraordinary inscription, at a village called Monteu, on the right side of the river Po, about sixteen miles from Turin ; and the same gentleman having lately sent us likewise an Italian dissertation printed at Turin, wherein the learned authors (Paul Ricolvi and Anthony Rivautella) undertake to discover, from the said inscription, and other concurring circumstances, the true place of the ancient city Industria, mentioned twice by Pliny ; a short account, collected from the whole, and translated into English, may prove not unacceptable.

This tripod, they say, far exceeds every thing of its kind, preserved hitherto in any of the cabinets in Europe, as well for its struc-

ture, as for the variety and elegance of the several relievos with which it is adorned. Each of its three pillars has on it four small figures: the first, which is placed at the top, represents a terminus of Venus; the second is a Victory, or a winged Fortune rather, standing with her feet on a globe; the third, which is near the middle of the pillar, is a Harpy, winged, with a woman's face; and the fourth figure, at the foot of the pillar, appears to be an old Silenus or Satyr, crouching himself together in an odd manner.

The pillars are joined to each other by little bars of metal, fastened by rivets at top, and rings at bottom, in such a manner that they may be closed together, or drawn asunder, at pleasure; and when they are extended to the utmost, the size of the tripod is somewhat more than a Turin foot, which, Dr. Bruni says, is equal to twenty English inches.

EQ. ROM. EQ. PYB.

These words imply that Lucius Pompeius, the person to whose honour this plate is inscribed, was a Roman knight, who had a stipend from the public. The Roman knights served at their own expence till the year of Rome 451, when their horses began first to be maintained at the expence of the commonwealth; and it appears, from various inscriptions under the emperors, that the words, *eques publicus, equo publico donatus*, or *ornatus*, &c. always mean a military dignity, and must be distinguished from the Roman knights towards the end of the commonwealth, who were a degree of citizens between the senators and the plebeians.

Q. ÆR. PET. ALIM.

It hence appears that Lucius Pompeius was *quæstor ærarii*, though only of the finances of the city Industria, and not of the emperor under whom he lived. Several other inscriptions are also produced, to prove the office of *quæstor alimentorum*; and a great deal of reading is introduced, to shew that the *quæstor alimentorum* was sometimes understood to be an officer having the care of the public allowance for bringing up children; and that at other times his office was understood to be the procuring all sorts of provisions for the use of the emperor's troops.

Passing by his office of *ædilis* and *duumvir*, we find he presided likewise over the receipt of the taxes, by this address to him,

CVRATORI
KALENDARIORVM. REI. P.

The days fixed for payment of the taxes and debts were registered in the public calendars; and creditors usually demanded their interest on the kalends, or first day, of every month: whence the register of the debtors, and the sums due, or the tribute to be paid by particulars to the public, and indeed the general state of the debts, and credit of every community, came to be called calendarium.

COLLEGIVM PASTOPHORORVM.

The college of priests called Pastophori, a name taken, as some suppose, from a very rich and ornamental upper garment termed pastos. As Pastophorus was a name given to Venus, these priests may have belonged to her, or else to the goddess Isis, whose chief priests, as Lucius Apuleius informs us, were called Pastophori, by way of pre-eminence, "*Unus——cœtu Pastophororum, quod sacrosancti Collegii nomen est, velut in concionem vocato, indidem de sublimi suggestu——renunciat*, &c." He says also, that the god Osiris had a college of them. His words are, "*Osiris——in collegium me Pastophororum suorum, imo inter ipsos decurionum quinquennales elegit.*" This body of priests had various offices, one might probably be the conferring honours on persons of great merit, as we find from our inscription those of Industria had done on Lucius Pompeius.

INDVSTRIENSIVM
PATRONO
OB. MERITA.

Hereby the city Industria acknowledges Lucius Pompeius as its patron or protector, and shows its gratitude for singular benefits received. Patrons and clients were in the earliest times of the commonwealth; but under the Emperors' inscriptions show us frequently, that cities and nations chose for their patron some eminent Roman citizens in favour with the prince, on whom they often conferred great honours.

T. GRAE. TROPHIMVS. IND. FAC.

These words on the cornice our authors wondered to find, as it was unusual for any but the most eminent painters and sculptors to put their names, and that only to the most famous and perfect of their works. Whence they conjecture, that this Titus Græcus Tro-

phimus of Industria might be not only the engraver of the inscription, but likewise the sculptor of some image to which this may have been the pedestal.

These gentlemen, who are authors of the Marmora Taurinensia, went to this village of Monteu in the autumn of the year 1743; where they found many inscriptions, with the names of various magistrates, both civil and ecclesiastical; which were certain proofs that some considerable city had been in that place formerly: and returning thither the autumn following, they found a broken stone; on which, by putting the pieces together, they could plainly read, that there had been decreed to a person named Cocceia, at the expence of the public, a statue AB. IND., which they interpret Ab Industriensibus, and suppose to mean the citizens of Industria.

. . . . . COCCEIÆ . . . . .
HA . . . EC . . AB. IND .
. . . . FVNERE. PV .
ET . STATVAM.

Some peasants about the same time, digging in the plain between the hills near the Po, discovered the vestiges of an ancient fabric, with some medals; and in the middle of the following February, found the traces of a large room, other medals, and some pieces of wrought brass; and in March they discovered this plate and tripod. Our authors mention also the discovery of many medals, a Mosaic pavement, the remains of an ancient temple, basso relievos, little images, ruins of edifices, and inscriptions found here; and give two passages from Pliny, mentioning this place.

In the first of these quotations, the city Industria is spoken of, as one of the noble cities that flourished in its time along the banks of the river Po, a little way to the south side of the Appenines. In the other he explains himself more fully, describing it to be near the Po, where that river begins to acquire a greater depth; and as a confirmation, gives its name still more ancient than that of Industria, viz. Bodincamagus, signifying in the Ligustine tongue, the river's being deeper at that place. And our authors affirm, that even at this day the Po, above and near Turin, is hardly navigable; but at Monteu, after having received not only the Dora, but the Stura, the Orco, the Mallone, and the Dora Balteo, it becomes much larger both in depth and width. They also take notice, that the hill near the plain

of Monteu is called Mondicoi, which they suppose a corrupted remain of the ancient word Bodincomagus. They find also in the bulls of this parish, that the parochial church is called Sancti Joannis Baptistæ de Lustria; which they conjecture may, by length of time, have been formed from the ancient name Industria.

From all these circumstances put together, they seem confident of their having discovered the real spot where this ancient city stood; and bring several reasons to prove, that Casal cannot possibly be the place, as some writers have imagined; and in order to show more fully the grandeur, magnificence, and antiquity, of this ancient city, they add several other inscriptions found at the same place.

[*Phil. Trans.* 1745.]

8. *On the Alterations which the Islands of Scilly have undergone since the Time of the Ancients, who mention them as to their number, extent, and position. By the Rev. William Borlase, M.A. F.R.S.*

The inhabitants of these isles are all new-comers; not an habitation worth notice; nor any remains of the Phenician, Grecian, or Roman art, either in town, castle, port, temple, or sepulchre. All the antiquities here to be seen are of the rudest Druid times; and, if borrowed in any measure from those eastern traders before-mentioned, were borrowed from their most ancient and simple rites.

We are not to think, however, but that Scilly was really inhabited, and as frequently resorted to anciently, as the old historians relate. All the islands (several of which are now without cattle or inhabitant) by the remains of hedges, walls, foundations of many contiguous houses, and a great number of sepulchral barrows, show that they have been fully cultivated and inhabited. That they were inhabited by Britons, is past all doubt, not only from their vicinity to England, but from the Druid monuments, several rude stone pillars, circles of stones erect, kist-vaens without number, rock-basins, tolmêns, all monuments common in Cornwall and Wales, and equal evidences of the antiquity, religion, and origin of the old inhabitants. They have also British names for their little islands, tenements, and creeks.

How came these ancient inhabitants then, it may be asked, to vanish, so as that the present have no pretensions to any affinity or connection of any kind with them, either in blood, language, or

customs? How came they to disappear, and leave so few traces of trade, plenty, or arts, and no posterity, that we can learn, behind them? Two causes of this fact occurred while Mr. Borlase was at Scilly, which may perhaps satisfy these inquiries: the manifest incroachments of the sea, and as manifest a subsidence of some parts of the land.

The sea is the insatiable monster, which devours these little islands, gorges itself with the earth, sand, clay, and all the yielding parts, and leaves nothing, where it can reach, but the skeleton, the bared rock. The continual advances which the sea makes on the low lands, are obvious, and within the last thirty years have been very considerable. What we see happening every day may assure us of what has happened in former times; and from the banks of sand and earth giving way to the sea, and the breaches becoming still more open and irrecoverable, it appears that repeated tempests have occasioned a gradual dissolution of the solids for many ages, and as gradual progressive ascendancy of the fluids.

Again, the flats, which stretch from one island to another, are plain evidences of a former union subsisting between many now distinct islands. The flats between Trescaw, Brêhar, and Sampson, are quite dry at a spring tide, and men easily pass dry-shod from one island to another, over sand-banks (where, on the shifting of the sands, walls and ruins are frequently discovered), on which at full sea there are ten and twelve feet of water. History confirms their former union. The isles Cassiterides," says Strabo, "are ten in number, close to one another; one of them is desart and unpeopled, the rest are inhabited." But see how the sea multiplied these islands; there are now reckoned one hundred and forty; into so many fragments are they divided, and yet there are but six inhabited.

But no circumstance can show the great alterations which have happened in the number and extent of these islands more than this, viz. that the isle of Scilly, from which the little cluster of these cyclades takes its name, is no more at present than a high rock, of about a furlong over, whose cliffs hardly any thing but birds can mount, and whose barrenness could never suffer any thing but sea-birds to inhabit it.

It has been mentioned before, that on shifting of the sands in the channel, walls and ruins are frequently seen; there are several phæ-

nomena of the name nature, and owing to the same cause, to be seen on these shores. Here then we have the foundations, which were probably six feet above high-water mark, now ten feet under, which together make a difference as to the level of sixteen feet. To account for this, the slow advances and depredations of the sea will by no means suffice; we must either allow, that the lands inclosed by these fences have sunk so much lower than they were before, or else we must allow, that since these lands were inclosed, the whole ocean has been raised sixteen feet perpendicular; which last will appear much the harder and less tenable supposition of the two. Here then was a great subsidence; the land between Sampson and Trescaw sunk at least sixteen feet, at a moderate computation. This subsidence must have been followed by a sudden inundation, and this inundation is likely not only to have destroyed a great part of the inhabitants, but to have terrified others who survived into a total desertion of their shattered islands. By this means, as I imagine, that considerable people, who were the Aborigines, and carried on the tin trade with the Phenicians, Greeks, and Romans, were extirpated. These islands are no longer what they were anciently, fertile in tin; nor are there any remains of such and so many ancient workings as could maintain a trade, so coveted by some of the ancients, and so industriously concealed by others. There are no mines to be seen in any of these islands, but only on one load (so we call our tin veins) in Trescaw island, and the workings here are very inconsiderable, and not ancient. It must therefore be matter of wonder where the Phenicians, Greeks, and Romans, could have found such a plenty of that useful metal. Whatever resources they had from Cornwall, formerly reckoned probably among the Cassiterides, great part of their tin must doubtless have come from these islands; but where it was found is uncertain. Nothing now appears above ground which can satisfy such an inquiry. The story of the Phenician vessel mentioned by Strabo to have purposely run ashore, and risqued the men as well as lost the ship, rather than discover to the Romans the trade to these isles, is well known, and proves beyond all doubt the commerce to have been very advantageous. That the natives had mines, and worked them, appears from Diodorus Siculus, lib. 5, ch. 2, and from Strabo, Geog. lib. 3, who informs us, that Publius Crassus sailing thither, and observing how they

worked their mines, which were not very deep, and that the people loved peace, and at their leisure navigation, instructed them how to carry on this trade to better advantage: that is, seeing their mines but shallow, yet well worth working deeper, taught them how to pursue the metal to a greater depth. The question then is, what is become of these mines? and how shall this question be answered, but by confessing that the land, in which these mines were, is now sunk, and buried under the sea?

Tradition seems to confirm this; there being a strong persuasion in the western parts of Cornwall, that formerly there existed a large country between the Land's-end and Scilly, now laid many fathoms under water. The particular arguments by which they support this tradition, may be seen in Mr. Carew's Survey of Cornwall, p. 3, and in the lad edition of Camden, p. 11.

But though there are no evidences, to be depended on, of any ancient connection of the Land's-end and Scilly, yet that the cause of that inundation, which destroyed much of these islands, might reach also to the Cornish shores, is extremely probable; there being several evidences of a like subsidence of the land in Mount's-bay. The principal anchoring place, called a lake, is now a haven, or open harbour. The mount, from its Cornish name *, we must conclude to have stood formerly in a wood, but now at full tide is half a mile in the sea, and not a tree near it.

[*Phil. Trans.* 1753.]

9. *Roman Tessellated Pavement discovered in Leadenhall-street,* *Dec.* 28, 1803.

The remains of this beautiful specimen † of mosaic work were found at the depth of nine feet six inches below the surface of the carriage-way pavement, in searching for the common-sewer.

It laid in the direction of N.E. to S.W. The S.W. angle of the outer border being about nine feet distant from the front of the eastern extremity of the portico of the East India-house.

The square dimension of the ornamented part here shewn, which forms the centre of the pavement, is nearly ten Roman feet, but the extent of the whole room was probably twenty-five Roman feet

* Guavas lake, signifying the grey rock in a wood.—Orig.

† See the Plate.

Engraved by Scott, from a Drawing by Clennell. For the Gallery of Nature and Art.

ROMAN TESSELATED PAVEMENT,
found in Leadenhall Street, in 1803.

London. Published by R. Wilks, 89, Chancery Lane, April 1, 1813.

square; as the remains of a Roman wall, evidently forming its N. W. angle, were found in opening the ground to the northward. The common-sewer makes a circular turn round this angle.

All the tesseræ are of burnt clay, except the purple and green of the drapery about the Bacchus; which are of glass. The tesseræ are bedded in a thin body of cement, on a layer of composition, one inch and a half in thickness, seemingly composed of pounded brick, lime, and pebbles, under which was a very deep bed of loam, or virgin earth. Part of a human jaw-bone, containing two of the teeth, together with the bones of a finger, were found immediately under the angle of the south-west border, with some fragments of pottery, apparently part of an urn.

Great pains have been taken to render this engraving an accurate copy of the original, preserving the due tint of its colours, and shewing the form and manner of placing the tesseræ. Those parts of the pavement which are defective, are denoted by five lines drawn across them.

The Honourable East India Company have, with their usual liberality, been at the expense of taking up the remains of this pavement, and they are now deposited in their library.

EDWARD LASSIDGE.

Hyde-street, Bloomsbury, May 1804.

CHAP. XXVIII.

MINES, METALS, AND METALLINE EARTHS.

SECTION I.

Introductory Remarks.

THIS branch of science is comparatively recent. The ancients have left us little that is valuable on the subject. Theophrastus wrote a Treatise on Stones, which was translated into English by Sir John Hill, and first brought him into the notice of the public. This translation contains many valuable notes, most of which have been pil-

laged by more recent mineralogical writers, without acknowledgement. Pliny, in the last two books of his Natural History, has likewise given us a treatise on stones; but it is very difficult to determine many of the species to which he refers*. The Arabian philosophers turned some of their attention to this subject; and Avicenna has left us a Treatise on Minerals. After the revival of learning in Europe, mineralogy acquired a portion of the attention of naturalists, as well as botany and zoology: but much less progress was made in it, partly on account of the difficulty of the subject, and partly on account of the infant state of chemistry, on which mineralogy is obliged to depend for a good deal of her exact information, as far as the division of minerals into species is concerned.

Linnéus's Mineralogy was far inferior to his arrangement of the two other kingdoms of nature; though he first brought into view the importance of crystallization, which has been laid hold of by the French mineralogists with such happy success in determining the species of minerals. It is hardly worth while to notice the various systems of mineralogy which made their appearance in various countries in succession, after the publication of the Linnæan system. But the first system of sterling value was that of Cronstedt; who formed his arrangement according to the composition of the various stones. His method was adopted by Bergman, in his Sciagraphia; by Werner, and by almost all succeeding writers on the subject.

The manner of describing minerals, and the technical language by which the description is conveyed, were invented by Werner, of Freyberg, who published his Treatise on the *External Characters*, in 1773. His mode of describing minerals has been universally adopted. As to the arrangement of minerals into species, two different methods are followed by the German and French schools. According to Werner, the species of minerals are merely artificial associations for the conveniency of description. Accordingly, he has made them to depend upon a certain agreement in all the external characters Haüy, on the other hand, conceives that minerals have been divided into species by nature herself, as well as animals and vegetables.

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* The late Dr. Walker, of the University of Edinburgh, understood Pliny's Account of Stones better than most persons. His new Mineralogical Nomenclature consist chiefly of words taken from Pliny, and used in the same sense with that writer. In that point of view it deserves some notice.

Identity of form constitutes, according to him, the specific character. Accordingly, all those minerals which have the same primitive form (with certain exceptions) are placed under the same species *. This method of Haüy recommends itself at once by its simplicity, and the exact limits which it enables us to assign to every species; whereas the Wernerians are obliged to admit, that different species pass, by imperceptible shades, into each other, and that many minerals exist which cannot be referred to any well-defined species, but lie intermediate between two. This is a necessary consequence of the opinion which they entertain, that nature has not divided minerals into species; but that species are merely artificial associations of minerals, contrived by the mineralogist for the convenience of arrangement and description.

The species of minerals at present known, and described by Werner, amount to about 300. But Haüy has reduced them to a much smaller number. And there can be no hesitation in admitting, that several of the Wernerian species might, without impropriety, be united together. As for example, zircon and hyacinth, corundum and adamantine spar, beryl and emerald, &c. His sub-divisions were made previous to the knowledge of the identity of the composition of these respective minerals, and he has not thought proper to alter it since.

From the newness of this branch of mineralogy, we are not to expect much valuable information on the subject in the Philosophical Transactions. Indeed by far the best papers on the subject have made their appearance very recently, and are contained in the volumes published since the commencement of the present century. There are thirty-eight mineralogical papers contained in the Philosophical Transactions; yet more than half of them are of very trifling value: while even the rest offer but few accurate descriptions of minerals; though the facts which they contain are useful in a historical point of view. One gives an account of the formation of cloth and paper from amianthus, discovered in Italy †. Another mentions the existence of a great quantity of native subcarbonate of soda in the neighbourhood of Smyrna, which the inhabitants of the country employed in making soap *. Another

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* See Young's Nat. Phil. II. 511.

† Phil. Trans. 1671. Vol. VI. p. 2167.

paper contains a description of the pits from which fullers'-earth is dug in Bedfordshire, by Mr. Holloway. These pits lie near Woburn, in a ridge of sand hills which run from Cambridge to Oxford, at the distance of about eight miles from the Chiltern hills. From the surface to the depth of about 14 yards, there occurs nothing but sand, through the middle of which, at about six yards from the surface, there runs a thin bed of red-coloured sandstone. The fullers'-earth lies under the sand, and is about eight feet thick. The first foot is so much mixed with sand as to be useless. The upper part of the fullers'-earth is coloured yellow, but it becomes lighter coloured as we descend deeper. Under the fullers'-earth is a bed of white rough stone about two feet thick, and below this occurs sand again; but no fullers'-earth occurs deeper. These beds are nearly horizontal, and extend a considerable way †.

The high value attached to diamonds depends not so much upon their beauty and hardness, as upon their great scarcity, and the labour and expence necessary in procuring them. Hitherto they have been observed only in the torrid zone, and Brazil is the only country in America where they have been found. There is a paper in the Philosophical Transactions giving an historical account of their discovery in that country by Dr. De Castro Sarmento. Near the capital of the county Do Serro do Frio flows the river Do Milho Verde, where they used to dig for gold, or rather to extract it from the alluvial soil. The miners, during their search for gold, found several diamonds, which they were induced to lay aside in consequence of their particular shape and great beauty, though they were ignorant what they were. At last, in the year 1728, a miner came to the country, who, suspecting there stones to be diamonds, made some experiments on the subject, and satisfied himself that his conjecture was well founded. He set himself in consequence to search for diamonds in the alluvial soil of the country, and the other miners followed his example. Diamonds were even found among the sand of the river though in less abundance. Ever since that period the searching for diamonds in that country has been continued with good success ‡. The specific gravity of diamonds

* Phil. Trans. 1696. Vol. XIX. 228.

† Phil. Trans. 1723. Vol. XXXII. p. 419.

‡ Phil. Trans. 1731. Vol. XXXVII. p. 199.

was first accurately determined by Mr. Ellicot, who employed a balance for the purpose that turned with the 200th part of a grain.* The following table exhibits the result of his trials:

	Diamonds weighed.	Weight in grain.	Sp. Gravity.
1	A Brazil diamond, fine water, rough coat	92·425	3·518
2	A ditto, fine water, rough coat	88·21	3·512
3	Ditto, fine bright coat	10·025	3·511
4	Ditto, fine bright coat	9·560	3·501
5	An East India diamond, pale blue	26·485	3·512
6	Ditto, bright yellow	23·33	3·524
7	Ditto, very fine water, bright coat	20·66	3·525
8	Ditto, very bad water, honey-comb coat	20·38	3·519
9	Ditto, very hard bluish coat	22·5	3·515
10	Ditto, very soft, good water	22·615	3·525
11	Ditto, a large red foul in it	25·48	3·514
12	Ditto, soft, bad water	29·525	3·526
13	Ditto, soft, brown coat	26·535	3·516
14	Ditto, very deep green coat	25·25	3·521
	Mean sp. gr. of the Brazil diamonds		3·513
	Mean ditto of East India diamonds		3·519
	Mean of both		3·517

Our accurate knowledge of the precious stones cannot be dated further back than the publication of Romé de Lisle's Crystallography, and has been very much improved of late years. Hence, a paper published in the Philosophical Transactions for 1747, by Mr. Dingley, giving a catalogue of the precious stones, and mentioning those employed by the ancients for engraving on, is an object of some curiosity. As he gives no other description of the stones which he mentions, except their colour, his account is involved in some obscurity. The following is his catalogue:

Beryl, red and yellow.†
Chalcedony.
Plasma, green with white spots.
Jacinth, deep tawny red.
Chrysolite, light grass green.
Crystal, or oriental pebble, silver white.
Garnet, deep red claret.

* Phil. Trans. 1745. Vol XLIII. p. 468.

† Probably jasper, cornelian, &c.

Amethyst, purple.
Diamond, white.
Ruby, red or crimson.
Emerald, deep green.
Aqua marina, bluish sea green.
Topaz, ripe citron yellow.
Sapphire, deep sky blue, or silver white
Cornelian, red or white.
Opal, white and changeable.
Vermillion stone, more tawny than jacinth.

All there are more or less transparent. The following are opaque:

Cat's eye, brown.
Red jasper, red ochre.
Jet, black.
Agates.
Blood stone, green, veined with red and white. *Heliotrope?*
Onyx, white and black.
Sardonyx, brown and white.
Agate onyx, two kinds of white opaque and transparent.
Alabaster, white and yellow.
Toad's eye, black.
Turquoise, yellowish blue inclining to green.
Lapis lazuli, deep blue.

The ancients engraved usually on the beryl (jasper), sometimes on chalcedony, plasma, and jacinth. Rarely on the chrysolite, crystal, garnet, and amethyst. They also engraved on several of the opaque stones.*

About the year 1757, in consequence of a dissertation on the subject published by Æpinus, and another by Wilke, the electrical properties of the tourmaline † came to be accurately known. At that time, the stone itself was considered as very rare, and as a great curiosity, though it is now known to be a very common constituent of primitive mountains, and occurs abundantly in different parts of Great Britain. In the year 1759, Sir William Watson wrote a dissertation to prove that the *lyncurium* of the antients, a stone described by Theophrastus, and noticed by Pliny, was nothing else than the tourmaline; and the evidence which he adduces from the properties of the stone, and the circumstances respecting these properties noticed by Theophrastus, leaves little doubt that his conjecture is well founded ‡.

The art of detecting the ores of metals in the earth, and of working them with advantage, constitutes one of the most important objects of political economy. It was carried to a considerable extent

* Phil. Trans. Vol. XLIV. p. 502.

† Electric Schorl: a species of argillaceous crystallized earth.

‡ Phil. Trans. Vol. LI. p. 394.

by the Grecian States, especially the Athenians; and was likewise pretty successfully practised during the early period of the Roman empire. Of the modern nations of Europe, the Germans have paid the greatest attention to mining, and the French the least. Britain possesses many important mining districts, especially Cornwall, Anglesey, Northumberland, Cumberland, and Derbyshire. The mines in Cornwall and Derbyshire have been worked since the period of the Roman conquest of Britain, and probably long before that period; for the Phœnicians were in the habit of drawing tin from Spain and Cornwall, in the remotest ages of antiquity. It is a very remarkable circumstance, and a striking proof of the want of education among our miners, that notwithstanding the importance of our mining districts, and the vast quantity of iron, copper, lead, tin, and zinc, every year extracted from the bowels of the earth, in Great Britain, no systematic treatise on mining has ever made its appearance. We have some treatises on the subject, translated from the Spanish and German, all of them of a very old date, and, consequently, imperfect; but no general account has yet appeared of the practices followed in this country, in extracting the ore from the mine, and obtaining from it the metal which it contains. We have, indeed, some valuable works giving an account of the practices followed in particular districts, especially Cornwall and Derbyshire; and some important information on the mode of smelting, &c., in Watson's *Chemical Essays*; the most elegant chemical work which has hitherto appeared in any language, a work not appreciated in this country according to its value.

The papers on mining, contained in the Philosphical Transactions, amount to 29; and more than the half of these were published before the year 1672. Of these there are 15 which, in the present advanced state of our knowledge of the subject, cannot be considered as of any value. The rest consist, either in descriptions of particular mines, or in details of certain processes pursued in certain districts; and the following is an account of the most important statements which they contain.

1. The method of blasting rocks by gunpowder is now so familiar to miners, that little attention is paid to the importance of it. But the methods, practised before its introduction, were so imperfect, that the use of gunpowder may be considered as constituting an important era in mining. In a very early number of the Philoso-

phical Transactions, we have a description of the method of blasting rocks by gunpowder, by Sir Robert Moray, where the invention is ascribed to M. Du Son *.

2. Transylvania and Hungary have long been celebrated as mining countries, and supply annually a considerable quantity of gold. Dr. Brown, a physician of London, of considerable eminence, who travelled on the continent in 1668, communicated a description of these mines to the Royal Society, which was published in the Philosophical Transactions. He describes a salt mine of great note, near Eperies, in Upper Hungary, no less than 1080 feet deep. The ground was not rocky but clay; and the salt, being ground to powder, was used without any refining. The gold mines of Cremnitz, he describes as of the greatest value, and as having been wrought for 900 years. His description of the ore is so imperfect, as to be of no value; but he gives an exact detail of the mode of extracting the gold by amalgamation, a process lately so much improved by Baron Born and his coadjutors. There was a mine of mercury about seven miles from Cremnitz, but it was not wrought. Dr. Brown makes some curious observations on the filling up of the passages formerly dug out in the old mines. By the trickling down of moisture along the sides of these passages they gradually become narrower, and approach each other †.

3. The most extensive salt mines known are those in Poland, not far from Cracovia, at a small town called Wilizka. There is an imperfect description of them in the Philosophical Transactions. According to that account they are 1,200 feet deep; and about 1,000 miners are constantly employed in them. The horses kept under ground become speedily blind, in consequence of the sharpness of the salt; and the hoofs of one of them, who had been long in the mine, were as long again as usual ‡.

Salt had been prepared in Cheshire for many years by boiling down the salt springs which are common in that country; but in 1670, a rock of salt was discovered, from which they expected to be able to manufacture the article with greater advantage §.

4. There is a pretty long paper, published in the Transactions for

* Phil. Trans. 1665. Vol. I. p. 82.

† Phil. Trans. 1670. Vol. V. p. 1189.

‡ Phil. Trans. 1670. Vol. V. p. 1099.

§ Phil. Trans. 1670. Vol. 5. p. 2015.—See for a more detailed account of Salt Mines, and the mode of working them, Section IX. of the present chapter.

1671, giving an account of the method of working the tin mines in Cornwall, and of preparing and smelting the ore, and obtaining the tin. As the terms used are all provincial words, peculiar to the Cornish miners, without any explanation, the paper is not very intelligible to ordinary readers*. The publication of a dictionary, explaining all the words used by the miners in the different mining provinces of Great Britain, would be a work of considerable value, and would greatly facilitate the attempts that may be made to improve the state of our mines. Something of the kind indeed has been attempted with respect to Cornwall, but at a period when the science of mineralogy was not sufficiently advanced to admit of an explanation of any term.

5. It is very remarkable that diamonds, by far the most beautiful and most highly valued of all the precious stones, have hitherto been found only in the torrid zone, in India, and Brazil. The mines, as they are called, consist of nothing else than the alluvial soil, no doubt originally washed down from mountainous districts. In this soil, diamonds are found scattered very unequally; sometimes occurring in great abundance, sometimes very sparingly. In some places the stones are all small, never exceeding a few grains in weight; in other places they are occasionally found as heavy as nine ounces. Diamonds have never yet been observed in their original position; from which circumstance one would be apt to suppose that this repository must be some of the newest rocks; as these are the rocks which from their situation are most liable to be worn away. In the Philosophical Transactions there is a particular account of the different places in India, on both sides of the Ganges, where diamonds occur, the manner of digging and washing the soil, and the colour of the soils thus wrought. The paper was communicated to the Royal Society by the Earl Marshal of England †. The description of the soil and rocks is so imperfect as to convey no information. But there is one curious particular mentioned, that deserves to be noticed; we mean, the mode pursued by the Indians to dig through rocks. They kindled a fire on the rock, and when it was very hot they poured water on it. By this means the rock cracked and split into shivers for a certain depth; these fragments

* Phil. Trans. 1671. Vol VI. p. 2096. See also a paper on the same subject by Merret, Phil. Trans. 1678. Vol. XII. p. 949.

† See also on the same subject, Section IV. of the present chapter.

were removed, the fire again kindled, and water poured upon the hot rock as before. Thus they proceeded till they reached the requisite depth *.

6. Calamine is an oxide of zinc, which has been employed from time immemorial in the making of brass. There is in the Transactions, an account of the method followed by the miners in digging this ore out of the earth, and preparing it for sale†. Calamine occurs frequently in beds, and seems, in some cases, to exist in great abundance. The Mendip hills, in Somersetshire, were famous for their calamine mines; though, I believe, the ore is now pretty much exhausted in that quarter. From the description given of the calamine mines in Somersetshire, by Mr. Pooley it is plain that he considered the calamine as occuring in veins. It is always mixed with some galena or sulphuret of lead. It is dug out of the earth, and being broken into small pieces is exposed to the action of a current of water, which washes away the light earthy matter, and leaves the calamine. The whole is then thrown into deep wooden vessels full of water, and agitated for a considerable time. The galena sinks to the bottom, the calamine is deposited in the middle, and the earthy matter on the surface. The calamine, thus separated from its impurities, is ground to powder, and is then fit for sale ‡.

7. Dr. Nichols, Professor of Anatomy in Oxford, seems to have examined the structure of metallic veins with more accuracy than any other British writer of the early part of the last century. He published some observations on the mines of Devonshire and Cornwall, which possess some value §. He has given us an explanation of several of the Cornish words used by the miners, of which the following may serve as a specimen:

Load, a vein.
Living load, a vein containing metallic ore.
Dead load, a vein destitute of ore.
Flooking, a cross vein of stone; or dyke, as called in the North of England.

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* Phil. Trans. 1677. Vol. XII. p. 907.

† Pooley, Phil. Trans. 1693. Vol. XVII. p. 672.

‡ The practice followed at present, in Somersetshire, differs in several particulars from the account given in the text; though the object in view, and even the means employed, are the very same.

§ Phil. Trans. 1728. Vol. XXXV. p. 402, and 480.

Engraved by Lester from a Drawing

for the Gallery of Nature & Art.

VIEW OF AN IRON MINE.

Published by R. Wilks, Sept.r 15th 1813.

He has some observations on the crystals of tinstone, and on its specific gravity compared with that of tin, and on its colour, much more accurate than any to be met with in chemical books of the same period.

8. In the year 1751, there was a very rich copper mine wrought at the river Arklow, in the county of Wicklow, in Ireland. From this mine there ran a stream of blue-coloured water, of so deleterious a nature as to destroy all the fish in the river Arklow. One of the workmen, leaving an iron shovel in this stream, found it some days after encrusted with copper. This induced Mr. Johnston, one of the proprietors of the mine, to make a set of experiments on the subject, from which he concluded, that the blue water contained an acid holding copper in solution, that iron had a stronger affinity for the acid than copper, that the consequence of this affinity was the precipitation of the copper, and the solution of the iron when pieces of that metal were put into the blue water. These ideas induced the miners to dig a great many pits for the reception of this water, and to put bars of iron into them. By this means they obtained a very great quantity of copper, much purer and more valuable than the copper which they obtained from the ore itself by smelting *.

9. The superiority of Swedish iron over that of other countries, for the making of steel, is well known. Hitherto the British steel makers have not been able to employ British iron in their processes; they have found it too brittle to bear cementation. Attempts are at present making by some very spirited steel-makers at Sheffield; and from the products already obtained, good hopes are entertained of ultimate success. This superiority of the Swedish iron depends upon the great purity of the ore from which the iron is smelted. One of the most remarkable of these mines, if the name can with propriety be applied to it, is Tabern, a mountain of considerable size, composed entirely of pure iron ore, and occurring in a large tract of sand over which it seems to have been deposited. This mountain has been wrought for nearly these three hundred years, and yet its size is scarcely diminished †.

Few things are more curious or difficult to explain than the prodigious quantity of coral formed in the sea, especially in the tropical regions. Coral is the produce of different species of vermes, and it

* Phil. Trans. 1751. Vol. XLVII. p. 500 and Vol. XLVIII. p. 181.

† Ascanius. Phil. Trans. 1755. Vol. XLIX. p. 30.

consists chiefly of carbonate of lime. Now it is difficult to conceive where these animals procure such prodigious quantities of this substance. Sea water, indeed, contains traces of sulphate of lime, but no other calcareous salt, as far as we know. Hence it would appear, that these creatures must either decompose sulphate of lime, though the quantity of that salt contained in sea water seems inadequate to supply their wants, or, they must form carbonate of lime from the constituents of sea water, in a way totally above our comprehension. Be that as it may, there is one consequence of this copious formation of coral in the tropical regions of considerable importance to navigation, which has been clearly pointed out by Mr. Dalrymple, and is now pretty well understood. The winds and waves accumulate these corals in large banks, which, entangling the sand, gradually rise above the surface of the waves, and form islands. These, in process of time, probably by the agency of birds, become covered with vegetation, and frequently loaded with timber. The bottom of these islands is nothing else than a coral bank; the surface is a black soil, formed of a mixture of sand and decayed vegetable matter; the whole island is flat, long, and narrow, and extends usually in its greatest length from north to south, because, almost all the winds between the tropics blow either from the east or from the west. The sides of these islands frequently constitute a perpendicular wall; and the sea, at a little distance from them, is of unfathomable depth*.

The Abbé Vegni traced the hot mineral waters of St. Philip, situated at Radicovani, in Tuscany, on the road from Florence to Rome, to a small hill, composed of white marble, from which they flowed in several rivulets. He found that these waters deposited a great quantity of shining white tophus, with which, not only the sides of the channels, along which they flowed, became encrusted, but likewise all kinds of hard bodies that were thrown into them; and this, in such manner, that when the said tophus was dexterously broken off, it retained exactly the form and shape of the bodies on which it had been deposited. This tophus Mr. Raspe considers as exactly the same with white marble; and hence infers, that all white marble has been deposited from springs in this manner †. But the tophus in question is quite different in its character from *granular*

* Phil. Trans. 1767. Vol. LVII. p. 394.

† Phil. Trans. 1770. Vol. LX. p. 47.

lime-stone, to which true white marble belongs. It is the mineral well known under the name of *calctuff* white, susceptible of a fine polish, and, in many cases, very beautiful. It is often cut into slabs, and used for ornamental purposes; and, as it is composed of the same constituents with granular lime-stone, it may, and often is, called *white marble;* but, when the two minerals are compared, their difference is at once conspicuous. Granular lime-stone is a congeries of minute crystals; and, in some cases, as in the Parian marble, these crystals are of such a size that their form can be distinctly seen with the naked eye. But the grain of calctuff is extremely fine, and no appearance of crystallization can be observed in it. Its texture is similar to that of chalk, only more compact. Hence is is obvious, that the mode in which calctuff is formed can never be extended to the formation of *granular lime-stone.* Sir James Hall has shown, that chalk, shells, and, probably, likewise calctuff, when violently heated in close vessels, undergo a species of fusion, and assume the appearance of granular lime-stone. Bucholz has ascertained, that the same things take place even in open vessels, provided the heat be applied suddenly. How far these experiments will account for the existence of granular lime-stone in such abundance, and the contrast between it and chalk, shells, and calctuff, as Sir James Hall seems to think they will, is a very different question, and could not be discussed without the introduction of a variety of topics foreign to our present subject.

There is nothing which has contributed more essentially to the prosperity of Great Britain, or, which has tended more to produce and foster the important manufactures, by which this industrious and enterprizing island is distinguished, than the mines of coal, which are scattered in such profusion under its surface. We find every manufacturing town set down in the midst of a coal country: Bristol, Birmingham, Wolverhampton, Sheffield, Newcastle, and Glasgow, afford striking instances, and many more will readily occur to the recollection of every one who is acquainted with Great Britain. An accurate account of the different coal fields, in this island, would be a very valuable addition to our geognostic knowledge. Several excellent tracts on the subject have been published at different periods, especially by Mr. Williams, in his *Mineral Kingdom;* but, unfortunately, the terms employed in these tracts, being the usual ones employed by the miners, are too vague and too little understood to convey any

exact information. There is a paper in an early volume of the Transactions, giving an account of the coal mines of Mendip, in Somersetshire. They occur in that county, as every where else in the low country, and are not to be found in the hills. The beds of coal are not horizontal, but sloping, and they dip to the south-east at the rate of about twenty two inches per fathom. Hence they would speedily sink so deep that it would not be possible to work them, were it not that the beds are here and there intersected by perpendicular dykes, or veins, of a different kind of mineral, (sometimes clay, but usually green stone); and, upon the other side of this vein, they are all found considerably raised up. There are seven different beds of coal at Mendip, lying at regular distances below each other, and separated by beds of a different kind of matter. From the names which Mr. Strachey applies to these beds, it is impossible to make out the nature of every mineral which occurs. Sandstone, slate slay, and bituminous shale, seem to be the principal. The deepest bed of coal, which is ten inches thick, and is not considered as worth working, lies about thirty-eight fathoms, or 228 feet below the surface of the earth *

[*Thompson's Hist. of Royal Society.*]

To the above general and elegant history of the progress and present state of the science, drawn up from different parts of the work above referred to, it is only necessary to add a few detached facts in a more ample elucidation of the subject.

The process of mining is a combination of boring and digging. Shafts are sunk, levels are driven, and drains are carried off, by the help of picks or pickaxes, wedges, and hammers, the rocks being also sometimes loosened by blasting with gunpowder. In searching for coal, a shaft is sunk through the uppermost soft strata, and the rock is then bored, by striking it continually with an iron borer, terminating in an edge of steel, which is in the mean time turned partly round; and at proper intervals a scoop is let down, to draw up the loose fragments. In this manner a perforation is sometimes made for more than a hundred fathoms, the borer being lengthened by pieces screwed on to it; it is then partly supported by a counterpoise, and is worked by machinery; if it happens to break, the piece is raised by a rod furnished with a hollow cone, like an extinguisher, which is driven down on it. Sometimes the borer is fur-

* Phil. Trans. 1719. Vol. XXX. p. 906.

nished with knives, which are made to act on any part at pleasure, and to scrape off a portion of the surrounding substance, which is collected in a proper receptacle.

The expansive force of heat is frequently of great service in dividing rocks, or in destroying old buildings. This is sometimes done simply by the application of fire, as in the mine of Rammelsberg, in the Hartz, where the stratum containing the ore is of such a nature, partly, perhaps, on account of the combustible matter which enters into its composition, that, by the effect of a large quantity of fuel, which is burnt in the vast excavation, of which it forms the side, it is rendered so friable as to be worked with ease. More commonly, however, the force of gunpowder is employed, and rocks are generally blasted with great convenience by an explosion of this powerful agent. A hole being bored to the depth of three or four feet, the powder is placed at the bottom, and a wire being introduced, small stones and sand are rammed round it, and the wire is withdrawn, leaving a communication for firing the powder, by means of a train of sufficient length to insure the safety of the workman. It is said that the explosion is more efficacious when the powder does not fill the whole of the cavity; this, however, appears to require confirmation.

The daring ingenuity of man, however, has led him to still bolder and more efficacious methods: for the mineralogists at Philipsthal, in East Prussia, have lately availed themselves of the force of lightning to accomplish the same end. For this purpose an iron rod, similar to a conductor, is fixed in the work that is intended to be blasted; when the occurrence of the first thunder-storm generally conveys the electric fluid down the rod in such quantity as to split it into several pieces without displacing it.

Granite is usually worked by driving a number of thin wedges very gradually into it, at various parts of the section desired; and sometimes wedges of wood are employed, which being moistened by water, their expansion separates the parts from each other. It is also said that many stones may be divided by drawing lines on them with oil, and then exposing them to heat. Perhaps some processes of this kind might be performed with advantage under water; it is well known that glass may be cut in a rough manner under water, without much difficulty, by a common pair of scissors.

Marble is made smooth by rubbing one piece on another, with

the interposition of sand; the polishing blocks are sometimes caused to revolve by machinery in a trough, in which the marble is placed under water, and are drawn at the same time gradually to and from the centre; or the slab itself, with the frame on which it rests, is drawn slowly backwards and forwards, while the blocks are working on it. Granite is polished with iron rubbers, by means of sand, emery, and putty; it is necessary to take care during the operation that the water, which trickles down from the rubbers, and carries with it some of the iron, may not collect below the columns, and stain them: but this inconvenience may be wholly avoided by employing rubbers of glass.

In further explanation of the system of crystallization as proposed by the Abbé Haüy, it may be necessary to observe, that this ingenious mineralogist considers all calculations of forms of crystals are reducible to arrangements of parallelopipeds, but he more commonly refers them to three species of primitive molecules, the tetraedron, the triangular prism, and the parallelopiped, making by their combinations, first, six primitive forms of crystals, which are only divisible in planes parallel to their surfaces, the tetraedron, parallelopipeds, octaedrons, regular or irregular, hexaedral prisms, the dodecaedron of equal rhombi, and the dodecaedron of two hexagonal pyramids. These, as they are built up in various orders, decreasing by regular steps, which begin either at the side, or at the angles of a crystal, serving as a nucleus, form all the immense variety of crystalline figures. A dodecaedron of rhombi sometimes composed of cubes; a dodecaedron of pentagons may be produced by the same elements with a different law of decrement: a cube is sometimes the nucleus of an octaedron of which the sides correspond to the angles of a cube.

The molecules of ice are supposed to be either cubes or tetraedrons; the diagonals of the surfaces of the calcareous rhombus, or, the Iceland crystal, are as of the square roots of 3 and 2, the obtuse angle of the surface 101° 32′ 13″, that of the contiguous planes 104° 28′ 40″. A. P. 1789. and Tr. Phys.

[*Editor.*]

SECTION II.

Metallic Mines and Earths of the Continent of Europe.

According to ancient writers, the mountains of Spain were very rich in gold and silver; Mr. Gibbon calls this kingdom "the Peru and Mexico of the old world." He adds, "the discovery of the rich western continent by the Phœnicians, and the oppression of the simple natives, who were compelled to labour in their own mines for the benefit of strangers, form an exact type of the more recent history of Spanish America*. The Phœnicians were acquainted only with the sea-coasts of Spain; avarice as well as ambition carried the arms of Rome and Carthage into the heart of the country; and almost every part of the soil was found pregnant with copper, silver, or gold: mention is made of a mine near Carthagena, which yielded every day 25,000 drachms of silver, or 300,000l. a year.†

Twenty thousand pound weight of gold was annually received from the provinces of Asturia, Galicia, and Lusitania ‡. The modern Spaniards choose rather to import these metals from America than to have the trouble of searching for them in their own country; but the iron mines are worked here with great skill. "Money," observes Mr. Gibbon, "is the most universal incitement, iron the most powerful instrument of human industry." Spain has also other minerals, as lead, tin, cinnabar, quicksilver, alum, vitriol, copperas, lapis calaminaris, and likewise crystal, amethysts, and other gems.

Portugal is in many parts mountainous, and these mountains contain the ores of silver, copper, tin, and iron; but the Portuguese, like the Spaniards, being supplied with metals from their possessions in other parts of the globe, and particularly with abundance of silver and gold from South America, no mines are worked in their own country. Gems of all kinds, as turquoises and hyacinths, are also found in the mountains; and particularly a beautifully variegated marble, with many other curious fossils of the lapidary kind, of which several sorts of work are made: here are also very good mill-

* Decline and Fall of the Roman Empire, 4to. Vol. I. p. 194.

† Strabo, lib. iii. p. 191.

‡ Plin. Hist. Nat. lib. xxxiii, cap. 3.

stones; and on the hill of Alcantara, not far from Lisbon, is a remarkable mine of salt-petre.

Dalmatia in ancient times produced much gold. Pliny says that under the emperor Nero, fifty pounds of gold were taken daily from the mines of that province, and that it was found upon the surface of the ground *. Florus writes, that Vibius, who was sent by Augustus to subdue the Dalmatians, obliged that fierce people to work in the mines, and to cleanse the gold. Martial likewise writing to Macer, calls Dalmatia *terra aurifera;* and it appears, by a verse of Statius, that the gold of Dalmatia was proverbial.

According to the accounts of many who have travelled in Bossina, that country contains many mineral mountains, and has rich mines of gold and silver. The place where these are found is named *Srebrarniza*, which means, country or land of silver, being derived from the word *srebr*, signifying silver in all the Slavonian dialects. The Abbé Fortis had a specimen of this mine, and found it to resemble the native silver of Potosi. It is in small, thin leaves, like moss, and is found combined with pure yellowish quartz, but unmixed with it †.

The kingdom of Norway formerly produced gold; but the expence of working the mines, and procuring the pure ore, being greater than the profit, they have been neglected. There are, however, silver mines, which are extremely valuable, and give employment to several thousand persons. The principal of these is at Konigsberg, but other silver mines are worked at Jarslberg, though not to the same advantage, the ore being mixed with lead and copper. In many parts of this country copper-mines have been discovered, the richest of which is at Roraas, about a hundred English miles from Drontheim, which annually yields eleven hundred ship-pounds of pure copper, each ship-pound being equal to twenty English stone in weight. Iron is still in greater plenty, many hundred thousand quintals being annually exported, chiefly in bars, and the rest cast into cannon, kettles, stoves, and the like. Here are likewise some lead-mines, but none either of tin or quicksilver.

Kongsberg is a flourishing mine-town, that contains no less than 10 or 11,000 souls, among whom many are Danes, and many Germans. A mint was set up in this town as early as the year 1686,

* Hist. Nat. lib. xxxiii, cap. 4.

† Travels into Dalmatia, p. 114.

and in 1689 the mine-college was erected. Kongsberg is most famous for its silver mines, which are the richest in all Norway. These were discovered in 1623, upon which the town was immediately built, and peopled with German miners. In 1751, forty-one shafts and twelve veins were wrought in the four reviers of this mine, in which 3500 officers, artificers, and labourers, are usually employed. The rich ore in this mine is found only in dispersed strata and interrupted veins. Even pure silver is sometimes dug out of it; and in 1647 some gold was found among the silver, of which Christian IV. caused the famous Billen ducats to be coined, with this legend, VIDE MIRA DOMINI: "*Behold the wonderful works of the Lord.*" In 1697, a vein of gold was discovered here, of which ducats were coined, that on one side had this inscription, CHRISTIAN V. D. G. REX DAN, NORW. V. G. The legend on the reverse was from the book of Job: "VON MITTERNACHT KOMMI GOLD; *Out of the north cometh gold.* Kongsberg, Dec. 1, 1697 *."

These mines are in a mountain between Kongsberg and the river Jordal; yet it has been found that the silver ore is not, as was at first imagined, limited to that mountain, but extends its veins for some miles throughout the adjacent districts; which is proved by the new mines that are from time to time undertaken in several places, and most of them carried on very prosperously. One of the most ancient and rich of all the mines, named "Old God's Blessing," has sometimes, within a week, yielded several hundred pounds weight of rich ore. This mine fills the beholder with amazement at its astonishing depth, which is no less than an hundred and eighty perpendicular fathoms; and the circumference at the bottom forms a clear of some hundred of fathoms. Here the sight of thirty or forty piles burning on all sides in this gloomy cavern, and continually fed, in order to mollify the stone in the prosecution of the mines, seems, according to the common idea, an apt image of hell; and the swarms of miners,

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* The passage here referred to is chap. xxxvii. 9. in our common rendering, "Out of the North cometh COLD." It is hardly to be supposed that the superintendants of the Danish mines could, in the above change of reading, intend a mere pun: and it is probable, therefore, that the Hebrew scholar from whom they received the text, for קרה (*cold*) read קרח *glittering, corruscation, crystals, precious stones,* or *ores.* Yet the established Danish lection gives *cold*, in accordance with our own text: *Og ved de ad predende vinde mod-norden kommer* KULD.

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covered with soot, and bustling about in habits according to their several employments, may well pass for so many infernal spirits; especially when, at a signal that a mine is going to be sprung in this or that course, they roar aloud, "Berg-livet, Berg-livet!" Take care of your lives!

SIBERIAN MINES.—Catherineburg may be esteemed the centre of all the Siberian mine-works belonging to the crown; on which account the director of the Russian mines resides there, and issues his instructions to the other directors of the works, and passes their accounts. The water of the river Isett is raised by a dam ninety-eight fathoms long, three fathoms high, and twenty broad, in order to supply a great number of mills and other engines belonging to the mines. All the forges and works about the town are kept in a good condition, and the miners and artificers work with extraordinary spirit and diligence.

In HUNGARY, in the county of Altsohl, which abounds in valuable ores and minerals, is Herrengrund, which has the appearance of a town lying among the tops of mountains; and all its inhabitants are miners. It is famous for its vast copper-works, and its vitriol, by which iron is apparently turned into copper; and several hundred weight of iron is thus changed every year. The vitriol, indeed, does not properly transform the iron into copper, but insinuates into it the copper particles with which it is saturated; and this seeming transmutation requires only a fortnight or three weeks: but if the iron be suffered to lie too long in this vitriolic liquor, it becomes at last reduced to powder.

In this district is Neusohl, a royal free town, and the best of the mine towns. It is situated on the river Gran, and built much in the Saxon manner. The adjacent mountains abound with copper-ore. Provisions here are good and cheap, but the smelting-works give the air an unhealthy taint.

The sands of the Rhine contain gold on the shores near Germerschein and Selz. It is here washed, and the gold is worked into florins. The elector farms these sands to contractors.

About forty miles to the south of the Carpathian hills are the gold mines of Cremnitz; and twenty English miles farther to the south the silver mines of Shemnitz; cities which have arisen solely from their labours, and are thence called mining towns. Cremnitz is esteemed the principal, and the ores are found in what Baron de Born

styles metallic rock. The mines of Cremnitz also produce some silver. Hungary is moreover enriched with a mineral peculiar to itself, or at least which has not hitherto been discovered elsewhere, we mean the opal—a gem preferred to all others by the oriental nations. The opal mines are situated at Ozerwiniza, a short day's journey to the north of Kaschaw. The hill in which they are found consists of decomposed porphyry; and they only occur at the distance of a few fathoms from the surface, of various qualities, from the opake white, or semi-opal, which last is also discovered in Cornwall, to the utmost effulgence of iridescent colours which distinguishes this noble gem.

Transylvania and the Bannat have also numerous and valuable mines. They consist chiefly in grey gold ore, and white gold ore. The finest gold is to be found at Ohlapian, not far from Zalathna, intermixed with gravel and sand *.

[*Strabo, Pliny, Ferber, Lefevre, Journal des Mines, Payne.*]

SECTION III.

Mines of Precious Stones and Ores in Asia.

THE fossil wealth of Asia rather consist of its gems than in its metals. The Island of Japan seems to be the most productive of gold of any part of that quarter of the globe; and there it is found in several provinces. The greatest quantity of gold which is procured in this quarter is melted out of its own ore, but some is washed out of the sands, and a small quantity is also contained in the ore of copper. The Emperor claims a supreme jurisdiction not only of all the gold-mines, but of all the mines of the empire, none of which may be worked without a license obtained from him; for of the produce of all the mines that are worked he claims two-thirds, and the other third is left to the lord of the province in which the mines lie; but as these lords generally reside upon the spot, they take care to render their share nearly equal to that received by the Emperor. The richest gold-ore, and that which yields the finest gold, is dug up in one of the northern provinces of the great island Niphon; these mines formerly yielded great quantities of that valuable metal, but the veins there, and in most of the other mines, do not at present produce any thing like the quantities they did formerly. Among

* For the quicksilver mine at Idria, see Section VI. of this chapter.

the other gold mines, there is one in the province of Tsckungo; but it is so full of water, that the people have been obliged to desist from working it. However, it being so situated that by cutting the rock, and making an opening beneath the mine, the water may be easily drawn off, this was attempted; but there happened to arise, just as they began, such a violent storm of thunder and lightning, that the men were obliged to fly elsewhere for shelter; and these superstitious people imagined that the tutelar god and protector of the place, unwilling to have the bowels of the earth thus rifled, raised this storm in order to make them sensible how much he was displeased at such an undertaking; and hence no farther attempt was made, for fear of incurring his displeasure.

The silver found in Japan is very fine, and there are mines of it in several places, particularly in the northern provinces.

One of the provinces also affords a small quantity of tin, which is so exceeding fine and white that it almost rivals silver: but the Japanese make little use of this metal.

Copper is the most common of all the metals in Japan. Some of it is the finest and most malleable of any in the world; other specimens are not only exceedingly fine, but mixed with a considerable quantity of gold, which the Japanese separate and purify. All this copper is brought to Saccia, one of the five principal cities, where it is refined, and cast into small cylinders, about a span and a half long, and a finger thick. There is, beside, a coarser sort of copper, which is cast into large flat cakes, and sold a great deal cheaper than the other. Brass is very scarce, and much dearer than copper; calamine being imported from Tonquin in flat cakes, and sold at an high price.

Iron is found in three or four of the provinces; and coals have been discovered towards the north of the island, and are largely worked there.

We have observed that the precious metals are but rarely to be met with in the soil of the Asiatic continent. Gold, however, is traced in the rivers which flow from Thibet into the Ganges and Indies; but no gold mines seem ever to have been known in Hindustan, which has been rather celebrated for attracting this metal in commerce from other countries. On the other hand Tibet, a mountainous country, offers it in more considerable abundance. Silver

seems rare in general throughout the oriental regions; and there is no indication of this mineral through all India. Thornberg mentions iron ore and plumbago among the minerals of Ceylon; but says nothing of copper, which seems also little known in Hindustan. It is indeed to be regretted that some curiosity has not been excited by the mineralogy of our possessions in Bengal, and the other regions of this interesting country; but the attention of the English to this great branch of science is very recent, and even the avarice of adventurers cannot be tempted to explore what is not known to exist. We have searched almost in vain for information upon this subject through the ponderous volumes of Dr. Buchanan; whose chief information is, that in the Irnada district gold is collected in the river which passes Nelambur in the Mangery Taluk, a Nair having the exclusive privilege of such collection, for which he pays a small annual tribute; and that iron is met with occasionally, and often plentifully, in Mysore and Malabar, washed down from the mountains in the form of black sand, and smelted as it thus descends; many of the furnaces for this purpose being of considerable extent.

DIAMOND MINES OF GOLCONDA. The kingdom of Golconda extends two hundred and sixty miles along the bay of Bengal, and is about two hundred miles, where broadest, from east to west. This country has neither mines of gold, silver, nor copper; it has many of salt and fine iron; but it is most famous on account of its diamond mines. The principal harbour is Musulipatan. The extent of this kingdom is from the gulf of Bengal to the kingdom of Visiapour, and from north to south is contained between those of Bahar and Carnate.

The diamond mines are generally adjacent to the rocky hills and mountains which run through the country, and it is supposed that they are to be found in all these mountains. In some of these mines the diamonds are found scattered in the earth, within two or three fathoms of the surface, and in others they are found in a mineral in the body of the rocks, forty or fifty fathoms deep. They here dig five or six feet into the rock, and then softening the stone by fire, proceed till they find the vein, which often runs two or three furlongs under the rock. All the earth is brought out, and being carefully searched, affords stones of various shapes, and of a good water. The earth in which they are found is of a yellowish, and

sometimes of a reddish colour, which frequently adheres to the diamond with so strong a crust that it is difficult to get it off.

In order to find the diamonds, the workmen form a cistern, made of a kind of clay, with a small vent on one side a little above the bottom; in this they put a plug, then throwing into the cistern the earth they have dug, pour in water to dissolve it. They then break the clods, and stir the wet earth in the cistern, the lighter part of which is carried off in mud when the vent-hole is opened to let out the water. Thus they continue washing till what is in the cistern is pretty clean; and then in the middle of the day, when the sun shines bright, carefully look over all the sand, at which they are so expert, that the smallest stone cannot escape them; for the brightness of the sun being reflected by the diamonds, assists them in the search; but if a cloud was to intervene, they would be apt to overlook them.

The undertakers watch the labourers very narrowly, lest they should conceal what they find; and take great care that the labourers expose to view no stone of a larger size than common, which if the governor should hear of he would cause it to be seized; for the governors of the mines enter into an agreement with the adventurers, that all the stones they find under a pagoda weight are to be their own; but the large ones above that weight belong to the king. A pagoda is nine mungellens, and the mungellen is five grains and three-fifths.

These governors generally use the adventurers and miners very tyrannically; and by their extortions, and the taxes they oblige them to pay, keep them poor; at least they are obliged to appear so, to avoid their impositions; and therefore both the merchant and the miner generally go naked, with only a cloth about their waist, and a turban on their heads. This only relates to Golconda; for in Visiapour they are said to be kindly treated, and permitted to enjoy their property; so that when they find in the mines of Golconda a larger stone than ordinary, they run away with it, and remove with their families to Visiapour.

This trade is almost entirely engrossed by the Banyans of Guzurat; and the workmen in the mines, as well as their employers, are for the most part Gentoos.

A few diamonds are also procured on the island of Borneo; and at Siam are found diamonds, sapphires, and agates, in the moun-

tains; but as the king's officers seize these for their master's use, the people have no encouragement to search for them. There are also load-stones in a mountain near the city of Louva, and also in the island of Jonsalam, or Junkselon, which is situated in the Malacca coast, near the eastern entrance of the bay of Bengal.

In the Florentine cabinet, a remarkable diamond used to be shewn under the old regime: it has long however been removed, and an exact model, made of yellowish glass, now supplies the place of it. The original, according to Tavernier, weighs a hundred and forty carats and a half, and was the largest diamond in Europe, till Mr. Pitt brought from the East Indies a diamond that exceeded it, which was sold to the Regent of France, and was the most costly and superb jewel belonging to that crown; but that jewel, together with the rest of the regalia, was stolen, soon after the storming of the palace and massacre of the Swiss guards, on the memorable 12th of August, 1792. But two diamonds much larger and more weighty have since been brought into Europe, one of which is in possession of the Queen of Portugal, and the other of the empress of Russia. The late Grand Duke Peter Leopold is said to have bought his diamond of a Jesuit for seventy-five thousand *scudi*, about eighteen thousand seven hundred and fifty pouunds, but the father had a most exorbitant profit, having given only a single paolo, or about seven-pence sterling, for it, on the Piazza di Navona, where it was offered to sale as a bit of crystal. This famous Medicean diamond, Lord Corke says, is removed to Vienna, and the Emperor, on days of festival and parade, wears it in his hat.

In the year 1772, the empress of Russia purchased the diamond above mentioned, which weighed seven hundred and seventy-nine carats, being exceeded in size and weight only by one in the possession of the Queen of Portugal; the diamond purchased by Lewis XIV. at the price of a hundred and thirty thousand pounds, known by the name of Pitt's diamond, not being one quarter part so ponde ous. The price paid for this jewel was one hundred thousand pounds sterling, and an annuity to the Greek merchant who owned it of four hundred thousand rubles, or near one thousand pounds sterling.

[*Thornberg. Pinkerton. Buchanan. Phil. Trans.*]

SECTION IV.

Metals and Ores of Africa.

THE kingdom of Mozambic is said to abound in gold, which is washed down by the rivers, and forms a chief part of the commerce of the country. The kingdoms of Monomopata and of Sofala likewise furnish considerable quantities; and the Portuguese who reside there, report that it yields the value of two millions of metigals annually, each metigal being valued at about fourteen French livres; and it is said that the merchants from Mecca and other parts export in time of peace, about the same quantity. The soldiers are paid in gold dust, just as it is gathered, which is so pure and of so fine a yellow, that it greatly exceeds most others, no other gold being superior to it but that of Japan.

Gold is likewise found on the island of Madagascar. The Gold Coast is so denominated from the abundance of gold found among the sands. The gold however is but scanty, and the heat intense. Egypt does not appear to have been rich in metals; yet a little iron is found, and towards Arabia manganese; garnets are occasionally met with; talc is abundant. And Mr. Roziere tells us that, in the mountains Baram, beyond the cataracts, he found a few ancient mines of lead and copper, formerly worked by the Egyptians, and in the neighbourhood several ruins of furnaces.

SECTION V.

METALS AND MINES OF AMERICA.

1. *Spanish Dominions.*

THE mines of LA PLATA (the country of silver) form a grand object of political regulation. They are chiefly situated in the provinces formerly strictly considered as Peruvian; for in fact Charcas, Tucuman, and even Buenos Ayres, were all regarded as dependencies of Peru, before the grand alteration or 1778. If New Spain be excepted, the upper part of the viceroyalty of La Plata, justly deserves the appellation given to the viceroyalty, being the richest country in silver which has yet been discovered on the globe, and not to speak of Potosi, the mines of gold and silver may be said to be innumerable. Lipes, Chichas, Porco, the chain of Aullagas pervading Chayanta, Oruro, Paria Carangas, Sicasica; in short, it may be

said that all the northern provinces teem with mineral opulence, while Laricaja and Carabaya are distinguished by virgin gold *.

Many of these mines are abandoned, not from the failure of the mineral, but from slight irregularities in the veins. There are traders who purchase the gold and silver, and when they have acquired three or four pounds weight of the former, they make a *tejo*, or round mass, and with two hundred marks of the silver form a bar or ingot, at the nearest royal station where the metals are essayed. They afterwards carry the tejos and bars to the mint, where they are purchased on the king's account, with a due profit to the sellers. This traffic, however, is accompanied with anxiety and labour, and requires economy. In imitation of this branch was founded the company of dealers in quicksilver at Potosi, which has also been styled for these forty years the Bank of Redemption. From its fund are supplied money, utensils, and other necessaries to expedite the work of the mines. The redemption of these produces such profit, that when it was divided, in the middle of last century, among the persons concerned, it amounted to more than one million of dollars. The chief object of the bank was to use the profits in assisting persons in urgent and accidental cases of the labour in the mines, so much exposed by nature to these events, and they thus continued to be employed till the year 1779, when it was yielded to the crown. In this bank his Catholic Majesty has a fund of 100,000 dollars, managed by three directors, and the benefits are not only extended to the mines of Potosi, but to those in the neighbourhood. The mark of rough silver is sold from seven to seven and a half dollars, according to the assay. The weekly purchases are from six to seven thousand marks, of which about five thousand are from the mountain of Potosi. The administrator of the bank brings this silver to the royal treasury, and in presence of the officers forms about thirty bars each about two hundred marks, which are weighed, assayed, and delivered with the necessary formalities. to pay the duties of tenths and *covos*. The bars being numbered, and stamped by the officers of the royal treasury, the administrator of the bank proceeds to the mint, where they are sold according to the estimate of the assayer; so that the business of the bank or of the king becomes as simple as that of individuals.

Since the year 1735 the metals only pay a tenth, instead of a fifth,

with one and a half per cent. of *covos*, an ancient duty given by the Emperor Charles V. to Don Francisco de los Covos, and afterwards assumed by the crown. Eleven and a half per cent. are then deducted for the dues of the bank, which yield to his majesty between three and four hundred thousand dollars. This bank, after paying the directors and officers rent and other expences, produces to the king a clear gain of about forty thousand dollars.

It has been generally allowed, that the mountain of Potosi alone produces weekly about five thousand marks of silver, that is, from thirty to forty thousand dollars, a circumstance sufficient to fill the world with admiration at the prodigious and inexhaustible opulence of this mountain, which has been assiduously wrought since 1545 *. At the beginning it was indeed more abundant, and the metal might be said to be pure; but at present it is somewhat reduced, and even inferior to some other mines, though it is always the most sure and permanent.

The benefit of the mines is open to all who choose to avail themselves of it, but labourers are not easily procured. Owing to the thinness of the population, scarcely one quarter can be found of the necessary number, Indians being always employed, and in this view no mine is so useful as that of Potosi, for every eighteen months there are sent from the provinces of the viceroyalty 6000 Indians, enrolled and divided into parties, in order to work in the mines. This expedition of Indians is called *mita*; and they are distributed

* This mountain, of a conic form, is about twenty British miles in circumference, and perforated by more than three hundred rude shafts, through a firm yellow argillaceous schistus. There are veins of ferruginous quartz, interspersed with what are called the horn and vitreous ores. Of a peculiar dark reddish colour, this mountain rises void of all vegetation, blasted by the numerous furnaces, which in the night formed a grand spectacle. This surprising mine was discovered, 1545, by Hualpa, a Peruvian, who in pursuing some chamoys, pulled up a bush, and beheld under the root that amazing vein of silver afterwards called *la rica*, or the rich. He shared this discovery with his friend Huanca, who revealed it to a Spaniard his master; and the mine was formally registered 21st April 1545. Specimens are not common in Europe; the silver often shoots in threads through a quartz approaching to agate.

In the province of Carangas, about 70 leagues W. from La Plata, are found in digging in the sands, detached lumps of silver called *papas* (potatoes) being formed like that root. Ulloa, lib. vii, c. xiii. Near Puno was a celebrated silver mine, from which the pure metal was cut with a chissel. Ib. c. xiv.

by the governor of Potosi according to the funds of the several mines, each being paid four reals a day, and treated according to the ordinance, till they complete their periods of labour. Without this measure the benefits of the mine would cease, as no labourers could be found, the great and sometimes useless expences incurred, and the loss which the royal treasury would sustain, if these mines were abandoned, having rendered the mita indispensable, and it is conducted with all possible humanity.

Latterly metal of base alloy has become more abundant, but sometimes lumps of pure gold or silver are found, which are called *papas*. The poor also occupy themselves in lavaderos, or washing the sand of the rivers and rivulets, in order to find particles of the precious metals. In the metallurgy quicksilver is indispensable, an arroba, and a little salt, being used for every fifty quintals of the mineral. The houses where the rock or stone is pounded is called *ingenios*, a name also given by the Spaniards to sugar-mills. Those of Potosi are magnificent and expensive, and are moved by water, though it be scarce and occasion many disputes. To estimate the riches of the mine or pit, if a certain proportion of the mineral yield ten marks, it is esteemed rich; if eight or six, middling; and if less, poor; but at Potosi, even two marks are advantageous to the adventurer.

The other mines are little permanent, being often lost in water, or the works giving way, or the vein falling, or the miner not being able to support the expences: but in recompence rich and new mines are daily discovered. They are all found in the chains of mountains, commonly in dry and barren spots, and sometimes in the sides of the noted *Quebradas*, or astonishing precipitous breaks in the ridges. This rule, however certain in the viceroyalty of Buenos Ayres, is contradicted in that of Lima, where, at three leagues distance from the Pacific, not far from Tagna, in the province of Africa, there was discovered not many years ago the famous mine of Huantajaya, in a sandy plain at a distance from the mountains, of such exuberant wealth that the metal is cut out as if with a chissel; and a large specimen of virgin silver may be seen in the royal cabinet of natural history at Madrid. This new mine has attracted around it a considerable population, though there be neither water nor pasturage for cattle, nor the common conveniencies for labour.

Such abundance of metals is produced in the northern parts of the

viceroyalty of La Plata, that in the mint of Potosi there are annually coined about 6,000,000 dollars; and it is generally supposed that the contraband trade is inconsiderable, as the remittances to Spain are found to correspond with the produce; and he adds, that all the mines of the viceroyalty may yield about 16,000,000 dollars; but this account must be compared with that of Helms, which shall be subjoined.

Besides gold and silver, copper is found at Arbicoya, near Oruro, and in the district of Lipes. A rich mine of tin is worked at Guanuni in the district of Paria; and abundant mines of lead in the province of Chichas *.

The following is the state of the mines in the new viceroyalty of Buenos Ayres, as reported by Helms.

Names of Provinces.	Gold.	Silver.	Copper Mines.	Tin.	Lead.
Tucuman - -	2	1	2		2
Mendoza - -		1			
Atacama - -	2	2	1		1
Lipez } province of Potosi	2	1	1		1
Porco } province of Potosi	1	2	1		
Carangas - - -		2	1		
Pacajes or Berenguela		1			
Chucuyoto - -		2			
Paucarcolla, Town Puno		1			
Lampa - - -		2			
Montevideo - -	1				1
Chicas and Tarija -	4	5			1
Cochabamba - -	1				
Sicasica - - -	2				
Laricaja - - -	4				
Omasuyos - -	4				
Azangaro - - -	3				
Carabaya - -	2	1			
Potosi - - -		1			
Chayanta - -	2	3	1	1	1
Mizque - - -		1			
Paria - - -		1		1	1
Total	30	27	7	2	7

* The Indians who work in the mines commonly chew the leaves of the *coca*, (Erythroxilum Coca) a litte plant about two feet high, chiefly cultivated in La Paz, and yielding three harvests a year. This plant so much invigorates the Indians that they can bear almost any fatigue; while, according to Alcedo, it burns the mouths of Europeans. In New Granada, it is called *hayo*, and somewhat corresponds with the betel of the East Indies.

Mexico or New Spain. The mines of this domain, or kingdom, as it is called by the Spanish writers, have been even more celebrated for their riches than those of *La Plata*. The best account we have received upon this subject will be found in M. Humboldt's *Essai Politique*, of which we shall here offer somewhat of an analysis, together with the observations of one of the writers in the Edinburgh Review.

It will surprise the generality of our readers, to be told that the silver mines of New Spain, the most productive of any that have been ever known, are remarkable for the poverty of the mineral they contain. A quintal, or 1600 ounces of silver ore, affords, at a medium, not more than 3 or 4 ounces of pure silver. The same quantity of mineral, in the silver mines of Marienberg, in Saxony, yields from 10 to 15 ounces. It is not, therefore, the richness of the ore, but its abundance, and the facility of working it, which render the mines of New Spain so much superior to those of Europe.

The fact of the small number of persons employed in the labour of the mines, is not less contrary to the commonly received opinions on this subject. The mines of Guanaxuato, infinitely richer than those of Potosi ever were, afforded, from 1796 to 1803, near forty millions of dollars in gold and silver, or very near five millions of dollars annually; that is, somewhat less than one-fourth of the whole quantity of gold and silver from New Spain; yet these mines, productive as they were, did not employ more than 5000 workmen of every description. The labour of the mines is perfectly free in Mexico; and no species of labour is so well paid. A miner earns from 25 to 30 francs a week; that is, from 5 to 5½ dollars; while the wages of the common labourer, are not more than a dollar and a half. The tenateros, or persons who carry the ore on their backs from the place where it is dug out of the mine, to the place where it is collected in heaps, receive 6 francs for a day's work of six hours. No slaves, criminals, or forced labourers, are ever employed in the Mexican mines.

Mr. Humboldt, who is well acquainted with the mines of Germany, points out many defects and imperfections in those of New Spain. One of the most obvious is the clumsy, imperfect, and expensive mode of clearing them from water; in consequence of which, some of the richest mines have been overflowed and aban-

tioned. Another great defect is the want of arrangement in the disposition of the galleries, and absence of lateral communications, which add to the uncertainty, and increase prodigiously the expense of working the mines. No plan of the galleries is formed, and no contrivance used for abridging labour, and facilitating the transport of materials. When new works are undertaken, they are often begun without due consideration, and always conducted on a scale too large and too expensive.

More than three fourths of the silver obtained from America is extracted from the ore by means of quicksilver. The loss of quicksilver in this operation is immense. The quantity consumed in New Spain alone is about 16,000 quintals a year; and in the whole of America, about 25,000 quintals are annually expended, the cost of which, in the colonies, Mr. Humboldt estimates at 6,200,000 livres. The greater part of this quicksilver has been furnished of late years by the mine of Almaden in Spain, and the residue was obtained from Istria in Carniola. In 1802, Almaden alone supplied more than 20,000 quintals. Huencavelica in Peru, which in the sixteenth century afforded for some years more than 10,000 quintals of quicksilver a year, does not yield at present quite 4000. Such being the case, it comes to be a question of infinite importance to America, how its mines are to be provided with quicksilver, if the supply from Spain and Germany should be cut off. Humboldt seems to be of opinion, that there are mines of cinnabar in America sufficient for the purpose. He enumerates several in New Spain and New Grenada, as well as in Peru; but, till they are worked or examined with greater care than they have been hitherto, it is impossible to judge what quantity of mercury they are capable of yielding. It is the supply of mercury that determines the productiveness of the siver mines; for such is the abundance of the ore, both in Mexico and Peru, that the only limit to the quantity of silver obtained from those kingdoms, is the want of mercury for amalgamation. The sale of quicksilver in the Spanish colonies has been hitherto a royal monopoly; and the distribution of it among the miners a source of influence, and possibly of profit, to the servants of the Crown. Galvez, to whom America is indebted for the system of free trade, reduced the price of quicksilver from 82 to 41 dollars the quintal, and thereby contributed most essentially to the subsequent prosperity and increase of the mines.

After concluding his account of the mines of New Spain, Mr. Humboldt gives a general view of the mineral riches of the other provinces of America. In Peru, silver ore exists in as great abundance as in Mexico. The mines of Lauricocha might be made as productive as those of Guanaxuato. But the art of mining, and the methods of separating the silver from its ore, are still more defective in Peru than they are in New Spain. Potosi is the principal mine in the viceroyalty of Buenos Ayres. Chili furnishes a small quantity of silver, and a large portion of gold. New Grenada and Brasil afford gold only.

The following table of the annual produce of the Spanish mines is calculated from the amount of the royal duties, and is therefore considerably under the truth. The gold is valued at 145 $\frac{82}{100}$ dollars, and the silver at 9 $\frac{4}{10}$ dollars the Spanish mark.

Name of the Provinces.	Pure gold, Spanish Marks.	Pure Silver, Spanish Marks.	Value of both in dollars.
New Spain................	7,000	2,250,000	22,170,740
Peru.....................	3,400	513,000	5,317,988
Chili....................	10,000	29,700	1,737,380
Buenos Ayres.............	2,200	414,000	4,212,404
New Grenada..............	18,000	very little	2,624,760
Total	40,600	3,206,700	36,063,272

To this sum Mr. Humboldt adds above three millions of dollars for contraband, and somewhat less than four and a half millions for the gold of Brazil. We have no means of judging how far he is correct in the allowance which he makes for contraband. But we strongly suspect, that his estimate of the quantity of gold from Brazil (taken from the work of Correa de Serra), is greatly exaggerated. Instead of 29,900 Spanish marks of gold, the quantity which he assigns to that colony, the best authorities state, that, sixteen years ago, Brazil did not furnish 20,000 marks annually; and that, for many years preceding, the supply from it had been diminishing every year. With this remark, we lay before our readers Mr. Humboldt's table.

Names of the Provinces.	Pure Gold. Spanish Marks	Pure Silver. Spanish Marks.	Value of both in Dollars.
New Spain	7,000	2,388,220	23,000,000
Peru	3,400	611,090	6,240,000
Chili	12,212	29,700	2,060,000
Buenos Ayres	2,200	481,830	4,850,000
New Grenada	20,505	—	2,990,000
Brazil	29,900	—	4,360,000
Total	75,217	3,460,840	43,500,000

According to this table, the quantity of gold annually furnished by America is, to the quantity of silver annually furnished by the same, as 1 to 46; and the total amount of both, in English money, (valuing the dollar at 4s. 4½d.) is 9,515,625l.

Mr. Humboldt proceeds next to inquire what has been the total quantity of the precious metals obtained from America since the first discovery of that continent: and, after a long discussion of the different opinions and conjectures on the subject, he concludes, that, from 1492 to 1803, the quantity of gold and silver extracted from the American mines has been equal in value to 5,706,700,000 dollars. Of this immense sum, he estimates the portion brought into Europe, including the booty made by the conquerors of America, at 5,445,000,000 dollars, which gives an average of 17½ millions a year. But this importation is far from having been constant or uniform, though, on the whole, it has been always progressive. The following table shows the amount of it at different periods, according to the enquiries and conclusions of Mr. Humboldt.

Periods.			Annual importation in Dollars.
1.	from	1492 to 1500	250,000
2.	—	1500 to 1545	3,000,000
3.	—	1545 to 1600	11,000,000
4.	—	1600 to 1700	16,000,000
5.	—	1700 to 1750	22,500,000
6.	—	1750 to 1803	35,300,000

The first period was that of exchange with the natives, or of mere rapine. The second was distinguished by the conquest and plunder of Mexico, Peru, and New Grenada, and by the opening of the first mines. The third began with the discovery of the rich mines of Po-

tosi; and in the course of it the conquest of Chili was completed, and various mines opened in New Spain. It was during this period that the great rise of prices, in consequence of the discovery of America, took place throughout Europe; and it is worth remarking, that this effect of the great introduction of gold and silver from America, was felt in the little island of Majorca about the same time that it was experienced in England, that is, about 1575. At the commencement of the fourth period, the mines of Potosi began to be exhausted; but those of Lauricocha were discovered, and the produce of New Spain rose from two millions to five millions of dollars annually: the fifth period begins with the discovery of gold in Brazil: and the sixth is distinguished by the prodigious increase of the mines of New Spain, while those of every other part of America, except Brazil, have also been improving. The average of the last period would have been much higher, if Mr. Humboldt, instead of taking the middle of the century, had chosen for its commencement the year 1772, when the great increase first took place in the mines of New Spain. Of this, we may be convinced by the mere inspection of his own tables*; from which it appears, that the average of the annual produce of the mines of New Spain, from 1750 to 1799, was 16,566,909 dollars; while the average produce of the same, from 1771 to 1803, was 19,688,940.

We will close this account with the following statement of M. Helms, of the whole coinage in Spanish America, from the first day of January, to the last day of December, 1790, taken from the official register.

	In Gold.	In Silver.	Total.
At Mexico,	628,044 piast.	17,435,644 piast.	18,063,688 piast.
At Lima,	821,168	4,341,071	5,162,239
At Potosi,	299,846	3,983,176	4,283,022
At Santiago, Chili,	721,754	146,132	867,886
Total	2,470,812	25,906,023	28,376,835

To account for the great difference of produce between the mines of Mexico, and those of Peru, Chili, and Buenos Ayres, Mr. Helms

* Page 580 and 581.

alleges the following reasons: 1. Because the kingdom of Mexico is much more populous than any other of the American provinces. 2. It is scarcely half the distance from the mother country, whence it is enabled the better to enforce obedience to the laws and regulations, habits of industry, good police, and economy. 3. The want of royal and private banks in Peru, where every thing is still in its primitive chaotic state. And, lastly, on account of the great encouragement which the industrious miner readily obtains in every commercial house of Mexico. If, concludes Helms, the provinces of Peru, Chili, and Buenos Ayres, were in a similar situation as that of Mexico, there is no doubt, that in Peru alone, on account of its incomparably richer, and more numerous gold and silver mines, four times the quantity of these noble metals might be obtained, and perhaps a still greater proportion, than what Mexico affords at present.

[*Helms. Humboldt. Edin.-Rev. Pinkerton.*]

2. *Portuguese Dominions.*

The mines of Brazil are by name, at least, well known to every one: and they have of late years been best described by M. Bougainville, and Mr. Mawe. The account we shall here offer, shall be drawn up from the remarks of both these writers.

Rio Janeiro, observes Bougainville, is the staple and principal outlet of the riches of Brazil. The mines called General, are the nearest to the city, at the distance of about seventy-five leagues. They yield to the king, every year, for his right of fifths, at least a hundred and twelve arrobas of gold; in 1762 they yielded a hundred and nineteen. Under the captaincy of the General Mines, are comprehended those of Rio do Morte, of Sabara, and of Serro-frio. The last, besides gold, produces all the diamonds that come from Brazil. They are found at the bottom of a river, of which they turn the course, in order to separate from the pebbles in its bed, the diamonds, topazes, chrysolites, and other stones of inferior quality.

Of all these stones, the diamonds alone are contraband: they belong to the undertakers, who are obliged to give an exact account of the diamonds found, and to place them in the hands of the intendant appointed by the king for this purpose, who deposits them immediately in a casket encircled with iron and shut with three locks. He has one of the keys, the viceroy another, and the assayer of the

royal treasury the third. This casket is enclosed in a second, sealed by the three persons above-mentioned, and which contains the three keys of the first. The viceroy has not the power of visiting its contents. He only consigns the whole to a third strong coffer, which he sends to Lisbon, after having set his seal on the lock. They are opened in the presence of the king, who chooses what diamonds he pleases, and pays the price to the undertakers at the rate fixed by their agreement.

The undertakers pay to his most faithful majesty, the value of a piastre Spanish money, each day, for every slave employed in searching for diamonds; and the number of these slaves may amount to eight hundred. Of all kinds of contraband trade that of diamonds is the most severely punished. If the offender be poor, it costs him his life; if he has wealth sufficient to satisfy the law, besides the confiscation of the diamonds, he is condemned to pay twice their value, to one year's imprisonment, and is afterwards banished for life to the coast of Africa. Notwithstanding this severity, there is a great contraband of diamonds, even of the most beautiful, the hope and ease of concealing them being increased by the small size of the treasure.

The gold drawn from the mines cannot be carried to Rio Janeiro, without being first brought to the smelting houses established in each district, where the right of the crown is received. What appertains to private persons is remitted in bars, with their weight, number, and an impression of the royal arms. All this gold is assayed by a person appointed for this purpose, and on each bar is imprinted the standard of the gold, so that afterwards in the coinage the operation necessary to estimate their due standard may be easily performed.

These bars belonging to individuals are registered in the factory of La Praybuna, thirty leagues from Rio Janeiro. In this station are a captain, lieutenant, and fifty men: here is paid the right of fifths; and besides a toll of a real and a half per head on men, cattle, and beasts of burden. Half of the product of this duty belongs to the king, and the other half is divided between the detachment according to rank. As it is impossible to return from the mines without passing by this office, all persons are there stopped, and searched with the greatest severity.

Individuals are afterwards obliged to carry all the gold in bars, which belongs to them, to the mint of Rio Janeiro, where the value is given in coin, commonly in half doubloons, each worth eight Spanish

dollars. Upon each of these half doubloons the king gains a dollar by the alloy and the right of coinage. The mint of Rio Janeiro is one of the most beautiful which exist; it is furnished with every convenience to work with the greatest celerity. As the gold arrives from the mines at the same time that the fleets arrive from Portugal, it is necessary to accelerate the work of the mint, and the coinage proceeds with surprising quickness.

The arrival of these fleets renders the commerce of Rio Janeiro very flourishing, but chiefly that of the Lisbon fleet. That of Porto is only laden with wines, brandy, vinegars, provisions, and coarse cloths, manufactured in that city or its environs. Soon after the arrival of the fleets, all the merchandise brought is taken to the custom-house, where it pays ten per cent. to the king. It is to be observed that at present, the communication of the colony of St. Sacramento with Buenos Ayres being severely prohibited, these rights must experience a considerable diminution *. Almost all the most precious articles were sent from Rio Janeiro to the colony of Sacramento, whence they were smuggled by Buenos Ayres into Chili and Peru; and this fraudulent commerce was worth every year to the Portuguese more than a million and a half of dollars. In a word, the mines of Brazil produce no silver; all that the Portuguese possess is acquired by this contraband trade. The negro trade was also an immense object to them. It is impossible to compute the loss occasioned by the almost entire suppression of this branch of contraband trade. It occupied alone at the least thirty vessels in the coasting trade from Brazil to La Plata.

Beside the ancient right of ten per cent. paid to the royal customhouse, there is another of two and a half per cent. imposed under the title of free gift, since the disaster at Lisbon in 1755. It is paid immediately on leaving the custom-house, whereas a delay of six months is granted for the tenth, on giving good security.

The mines of St. Paolo and Parnagua yield to the king four arrobas for the fifths every year. The most distant mines as those of Pracaton and Quiaba (Cuyaba), depend on the captaincy of Mato-groso. The fifth of the above mines is not received at Rio Janeiro, but that of the mines of Goyas is deducted. This captaincy also possesses diamond mines which are forbidden to be worked.

* The colony of St. Sacramento has since been destroyed.

The whole of the expence of the King of Portugal at Rio Janeiro, for the payment of the troops and civil officers, and for the charges of the mines, and the maintenance of the public buildings, the careening of vessels, amounts to about six hundred thousand dollars. The expences of building ships of the line and frigates there stationed are not included.

Recapitulation, and the amount of the average of different objects of royal revenue.

	Dollars.
A hundred and fifty arrobas of gold, the average produced by the royal fifths, are in Spanish money	1,125,000
The duty on diamonds - -	240,000
The duty on coinage - -	400,000
Ten per cent. from the custom-house -	350,000
Two and a half per cent. of free gift -	87,000
Right of toll, sale of employments, offices, and generally all the profits of the mines - -	225,000
Duty on slaves - - -	110,000
Duty on fish-oil, salt, soap, and the tenth on the provisions of the country - - -	130,000
Total	2,667,000

From which, deducting the above expences, it will be seen that the King of Portugal draws from Rio Janeiro, a revenue exceeding ten millions of French livres *.

An eminent Portuguese mineralogist, d'Andrada, has published an interesting memoir on the diamonds of Brazil †. He observes that Brazil borders on the W. on desarts and forests held by savages, while in the interior there are great chains of mountains, mingled with superb vallies and large fertile plains. Numerous rivers intersect wide forests of valuable timber. Brazil, says d'Andrada, is divided into four mineral *comarcás* or districts, which proceeding from S. to N. are, 1. St. Joao del Rey. 2. Villa Rica. 3. Sabara. 4. Serro do Frio, or the Cold Mountains, which last not only pro-

* 416,666*l.*

† In the first part, the only one ever published, of the *Actes de la Société d'Hist. Nat. de Paris*, Paris, 1792, folio,

duce diamonds, but are also very rich in mines of iron, antimony, zinc, tin, silver, and gold. The Paulists, or people of the government of St. Vincent, contributed greatly to the discovery of the interior, always going armed to defend themselves against the savages. Antonio Soary, a Paulist, was the first who visited Serro do Frio. The mines of gold were first disclosed; but diamonds were afterwards discovered in the Riacho Fundo, and next in Rio da Peixe. The diamonds are supposed originally to exist in the mountains, but they are more easily found in a bed under the vegetable earth, disseminated and attached to a gangart more or less ferruginous and compact. The diamond mines are farmed to individuals; and the negroes employed may amount to seven or eight thousand. He adds, that diamonds are often found in the soil of the mountains, in beds of ferruginous sand and pebbles, forming an ochraceous pudding stone, of the decomposition of emery, and what is calledboggy iron ore. This pudding stone is termed *caschalo;* and underneath there is a schistus, somewhat arenaceous, and sometimes indurated ore of iron. In the caschalo is also found gold in grains. It will readily occur to the reader, that the diamonds of Hindostan are also found in ferruginous sand. Iron also accompanies gold, and most other metals, so that a theorist might argue, that they are all modifications of iron. It is also remarkable that most of the metals are generally found together in the same mine. D'Andrada adds that diamonds have also been found in other provinces of Brazil, as Cuyaba, and St. Paul; but promising no superior advantages the mines have not been explored.

This is the most authentic information which has appeared concerning the mines of Brazil. They are situated in the mountains which give source to many streams that flow north and south, into the river Tocantin, on one side, and the Parana on the other, but there are mines of gold as far inland as the river Cuyaba, which flows into the Paraguay, and even near the river Itenas*. The diamond mines are near the little river of Milhoverde, not far from Villa

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* Others are near the river Piexe, and Saguitinhonha, the Riacho-Fundo, and Guarapara in St. Paul's. MS. Inf.

Coleti gives the following list of the mines of Brazil:

Cuyaba, *Diamonds.*
Geraes, *Gold.*
Guayaz, *Diamonds.*

Nova do Principe, in the province of Serro do Frio, S. lat. according to La Cruz 17°, about long. 44° W. from London. This singular substance is not certainly known to be produced in any other part of the world, except Hindostan, and chiefly about the same latitude, 17° N. ; but the diamonds of Brazil are not of so fine a water, being often of a brownish obscure hue. The river of St. Francisco is remarkable for passing a considerable way under-ground, after it has attained a great size *.

In Mr. Mawe's "Travels into the Interior of Brazil," we meet with much curious and some entertaining information on the same subject.

On his return to Rio Janeiro from a fruitless search after a re-

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Mato-grosso, *Gold.*
Picurú, *Silver.*

In the curious catalogue of the minerals belonging to Davila, a gentleman of Peru, Paris, 1767, 3 vols. 8vo. there is, ii. 109, red amianthus from the mines of Brazil, marked as extremely rare: and, ii. 260, little black garnets from the mines of Brazil, where they often appear six feet above the diamonds. There is also, p. 275, diamond of Golconda in a gangart of iron ore, with little grains of quartz.

* Adams in Ulloa, English translation, ii. 329.

Mr. Lindley's Narrative, 1805, presents some notice of this country, which, though not immediately connected with the subject before us, we shall quote as interesting. He assures us, p. 104, that the bitter or Seville orange, is a native of America, whence it was carried to Seville. There are great unwrought mines of nitre to W. S. W. of Bahia. He says, p. 162, that no vessel ought to approach the coast on the S. of Bahia, within half a degree, as all our charts are very defective in that part. The rainy season, p. 173, sets in about the middle of April ; and the winter is commonly as mild as in European September. The American camels, glama, vicuna, &c. are totally unknown in Brazil, and even in Paraguay, as would appear from the work of Azara, who has omitted them. Our author says, that the captaincy of Porto Seguro extends on the N. to the Rio Grande, where it meets the captaincy of Ilheos, or of the Seaholms But these Rios Grandes create great confusion in Spanish and Portuguese geography, the name Great River signifying nothing. This Rio Grande, and the adjoining Pativa, supply excellent timber for the royal docks, one kind resembling the teak of India, while Brazil wood, logwood, mahogany, rose wood, and others also abound. This Rio Grande has not been explored, but is supposed to rise beyond the mines of Pe-tangui, in the Serro do Frio, and is navigable for a great space. The Portuguese settlements seldom extend more than ten leagues inland. Captain Lindley has given, p. 295, a table of longitudes and latitudes on the coast of Brazil, taken from recent manuscript Portuguese charts.

ported silver mine at Canta de Gallo, he was consulted by the prime minister upon the following affair.

' A free negro of Villa do Principe, about nine hundred miles distant, had the assurance to write a letter to the Prince Regent, announcing that he possessed an amazingly large diamond, which he had received from a deceased friend some years ago, and which he begged he might have the honor to present to his Royal Highness in person. As the magnitude which this poor fellow ascribed to his diamond was such as to raise imagination to its highest pitch, an order was immediately dispatched to the commander of Villa do Principe, to send him forthwith to Rio de Janeiro; he was accommodated with a conveyance, and escorted by two soldiers. As he passed along the road, all who had heard the report hailed him as already honoured with a cross of the order of St. Bento, and as sure of being rewarded with the pay of a general of brigade. The soldiers also anticipated great promotion; and all persons envied the fortunate negro. At length, after a journey which occupied about twenty-eight days, he arrived at the capital, and was straightway conveyed to the palace. His happiness was now about to be consummated; in a few moments the hopes which he had for so many years indulged would be realized; and he should be exalted from a low and obscure condition to a state of affluence and distinction: Such no doubt were the thoughts which agitated him during the moments of suspense. At length he was admitted into the presence; he threw himself at the Prince's feet, and delivered his wonderful gem; his Highness was astonished at its magnitude; a pause ensued; the attendants waited to hear the Prince's opinion, and what he said they seconded. A round diamond, nearly a pound in weight, filled them all with wonder; some ready calculators reckoned the millions it was worth; others found it difficult to numerate the sum at which it would be valued, but the general opinion of his Highness's servants was, that the treasury was many millions of crowns the richer. The noise which this occurrence created among the higher circles may be easily conceived; the general topic of remark and wonder was the negro's offering. It was shewn to the ministers, among whom an apprehension, and even a doubt, was expressed, that a substance so large and round might not prove a real diamond; they however, sent it to the treasury under a guard, and it was odged in the deposite of the jewel-room.

'On the next day, the Condé de Linhares sent for me, and related all the circumstances which had come to his knowledge respecting this famous jewel, adding, in a low tone of voice, that he had his doubts about its proving a genuine diamond. His excellency directed me to attend at his office in a few hours, when letters from himself and the other ministers of the Treasury should be given me, for permission to see this invaluable gem, in order to determine what it really was. Readily accepting a charge of so interesting a nature, I prepared myself, and attended at the hour appointed, when I received the letters, which I presented at the Treasury to an officer in waiting. I was led through several apartments in which much business seemed to be transacting, to the grand chamber, where presided the treasurer, attended by his secretaries. Having my letters in his hand, he entered into some conversation with me relative to the subject; I was then shewn through other grand apartments hung with scarlet and gold, and ornamented with figures as large as life, representing justice holding the balance. In the inner room, to which we were conducted, there were several strong chests, with three locks each, the keys of which were kept by three different officers, who were all required to be present at the opening. One of these chests being unlocked, an elegant little cabinet was taken out, from which the treasurer took the gem, and in great form presented it to me. Its value sunk at the first sight, for before I touched it I was convinced that it was a rounded piece of crystal. It was about an inch and a half in diameter. On examining it, I told the governor it was not a diamond; and to convince him, I took a diamond of five or six carats, and with it cut a very deep nick in the stone. This was proof positive; a certificate was accordingly made out, stating, that it was an inferior substance, of little or no value; which I signed.'

The most interesting part of Mr. Mawe's book is that in which he gives an account of the diamond works on the river Jigitonhonha. This rich river is as wide as the Thames at Windsor, and in general from three to nine feet deep. The part now in working is a curve, from which the river is directed into a canal cut across the tongue of land round which it winds, the river being stopped just below the head of the canal, by an embankment of several thousand bags of sand. The deeper parts of the channel of the river are laid dry by means of large caissons, or chain-pumps worked by a water-wheel. The mud is then carried off; and the *cascalhao*, or earth, which con-

tains the diamonds, is dug up, and removed to a convenient place for washing. This labour was, until lately, performed by the negroes, who carried the cascalhao in baskets on their heads, but at present is performed by machinery. The stratum of cascalhao consists of the same materials with that in the gold district. On many parts by the edge of the river, are large conglomerate masses of rounded pebbles, cemented by oxide of iron, which sometimes envelop gold and diamonds. They calculate on getting as much cascalhao in the dry season, as will occupy all their hands during the months which are subject to rain. When carried away from the bed of the river where it is dry, it is laid in heaps, containing apparently from five to fifteen tons each. Water is conveyed from a distance, and distributed to various parts of the works by means of aqueducts constructed with great ingenuity and skill. The method of washing for diamonds at this place we shall give in Mr. Mawe's own words.

'A shed is erected in the form of a parallelogram, twenty-five or thirty yards long and about fifteen wide, consisting of upright posts, which support a roof thatched with long grass. Down the middle of the area of this shed a current of water is conveyed through a canal covered with strong planks, on which the cascalhao is laid two or three feet thick. On the other side of the area is a flooring of planks, from four to five yards long, imbedded in clay, extending the whole length of the shed, and having a slope from the canal, of three or four inches to a yard. This flooring is divided into about twenty compartments or troughs, each about three feet wide, by means of planks placed on their edge. The upper ends of all these troughs (here called canoes) communicate with the canal, and are so formed that water is admitted into them between two planks that are about an inch separate. Through this opening the current falls about six inches into the trough, and may be directed to any part of it, or stopped at pleasure by means of a small quantity of clay. For instance, sometimes water is required only from one corner of the aperture, then the remaining part is stopped; sometimes it is wanted from the centre, then the extremes are stopped; and sometimes only a gentle rill is wanted, then the clay is applied accordingly. Along the lower ends of the troughs a small channel is dug to carry off the water.

'On the heap of cascalhao, at equal distances, are placed three high chairs for the officers or overseers. After they are seated, the

negroes enter the troughs, each provided with a rake of a peculiar form and short handle, with which he rakes into the trough about fifty or eighty pounds weight of cascalhao. The water being then let in upon it, the cascalhao is spread abroad and continually raked up to the head of the trough, so as to be kept in constant motion. This operation is performed for the space of a quarter of an hour; the water then begins to run clearer; having washed the earthy particles away, the gravel-like matter is raked up to the end of the trough. After the current flows away quite clear, the largest stones are thrown out, and afterwards those of inferior size; then the whole is examined with great care for diamonds. When a negro finds one, he immediately stands upright and claps his hands; then extends them, holding the gem between his fore-finger and thumb. An overseer receives it from him, and deposits it in a gamella or bowl, suspended from the centre of the structure, half full of water. In this vessel all the diamonds found in the course of the day are placed; and at the close of work are taken out and delivered to the principal officer, who, after they have been weighed, registers the particulars in a book kept for that purpose.

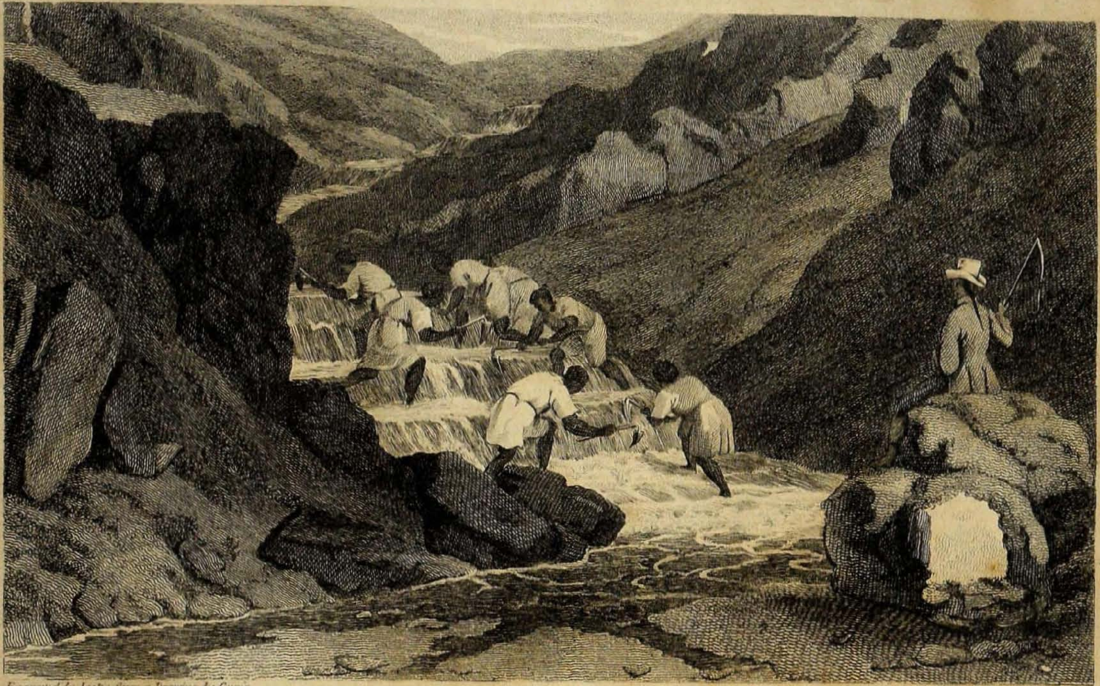
'When a negro is so fortunate as to find a diamond of the weight of an octavo ($17\frac{1}{2}$ carats much ceremony takes place. He is crowned with a wreath of flowers, and carried in procession to the administrator, who gives him his freedom, by paying his owner for it. He also receives a present of new clothes, and is permitted to work on his own account. When a stone of eight or ten carats is found the negro receives two new shirts, a complete new suit, with a hat and a handsome knife. For smaller stones of trivial amount, proportionate premiums are given. During my stay at Tejuco, a stone of $16\frac{1}{2}$ carats was found. It was pleasing to see the anxious desire manifested by the officers that it might prove heavy enough to entitle the poor negro to his freedom; and when, on being delivered and weighed, it proved only a carat short of the requisite weight, all seemed to sympathize in his disappointment.'

Many precautions are taken to prevent the negroes from stealing the diamonds. They work in a bent position, and cannot see the overseer, who sees them. For fear any diamonds should be concealed in the corners of the troughs, the negroes are changed frequently at the word of command of the overseers. If a negro is sus-

pected of swallowing a diamond, he is confined in a solitary room, and the whole powers of the materia medica let loose upon him.

The flat pieces of ground on each side the river are equally rich throughout their extent; and the intendants are able to ascertain, by admeasurement, how many thousand carats an unworked piece of ground will yield. The substances accompanying diamonds, and considered as indications of their proximity, are—bright, bean-like iron ore—a slaty, flint-like substance, approaching Lydian stone of fine texture—black oxide of iron in great quantities—round bits of blue quartz, yellow crystal—and other materials entirely different from any thing known to be produced in the neighbouring mountains. Diamonds are by no means peculiar to the beds of rivers or deep ravines; they have been found in water-courses, and cavities on the summits of the most lofty mountains. The officers of the establishment informed Mr. Mawe, that they often found diamonds cemented in pudding-stone, accompanied with grains of gold. Of the diamonds, some are so small that four or five only weigh a grain. There are seldom found more than two or three stones, of from 17 to 20 carats, in the course of a year; and not once in two years is there found, throughout the whole washings, a stone of 30 carats. During the five days Mr. Mawe was there, the whole quantity found amounted only to forty diamonds, the largest of which was only four carats, and of a light green colour.

After residing here five days, says he, we visited a diamond work called Montero, about two miles up the river, and went a league further to a gold-work called Carapata. The cascalhao at this work was taken from a part of the river eight feet deep, which formed an eddy under a projecting point; I was shown a heap of it, that was estimated to be worth 10,000l. In removing this heap from its bed, four hundred negroes had been employed three months; and to wash it, would occupy one hundred men for three months more, the expense of both operations amounting to perhaps 1,500l. We arrived at this place at eight o'clock in the morning; six negroes were employed four hours in washing two troughs, containing together about a ton of cascalhao, when, to my great surprise, after the water ran clear, and the large stones were thrown out, the black oxide of iron, of which there was great abundance, was fringed with grains of gold; a novel and very agreeable sight to a stranger. The gold was taken out at three or four different times, and, when the washing was



Engraved by Lester, from a Drawing by Craig. | for the Gallery of Nature & Art.

MANNER OF WASHING FOR GOLD IN THE BRAZILIAN MOUNTAINS.

London, Published Oct.r 15, 1814, by R. Wilks, 89, Chancery Lane.

completed, was dried over a fire and weighed; it amounted to nearly twenty ounces Troy.

There is a curious anecdote detailed by Mr. Mawe, of three criminals, fugitives from justice, who by accident, found a diamond, an ounce in weight. No man could be guilty to whom Providence had shown such favour. They were all three pardoned by the Court of Lisbon, and the clergyman whom they chose as their diamond-bearer and intercessor, was amply provided for in the church. By Mr. Mawe's calculation it appears that the diamonds, when brought to market, actually cost government thirty-three shillings and ninepence per carat. As all the diamonds found in these works belong to the Crown, the Royal Family have been accustomed to select such as they considered worth their notice: They were formerly sent to Holland to be cut; but since the emigration of the Court, that business has fallen into the hands of the English lapidaries. The collection of diamonds now in the possession of the Prince Regent of Portugal, exceeds three millions sterling.

[*Bougainville*, *Mawe*.]

3. *United States.*

The mineralogy of the United States is yet far from being completely explored, and the following are the only imperfect notices we can give.

Rich mines of gold or silver, so common in the adjacent Spanish territories, have not yet been discovered in any part of the United States*. Yet gold has been found in considerable quantities in the county of Cabarrus, in the state of North Carolina †, in so much, that of the gold coinage 1804, about eleven thousand dollars in value were the produce of virgin metal from that country. The director of the mint observes, that "it is to be regretted that this gold is melted into small ingots before it is sent to the mint, for the convenience of carriage; but by which, there is reason to believe, a considerable portion of it is wasted. It is also said, that the finest particles are neglected, and only the large grains and lumps sought after." At Philipsburg, in New York, there is said to be a silver mine, producing that metal in a virgin state; but as no specimens

* Morse, p. 391.

† Report, Washington, 1805, 8vo.

occur in European cabinets, it is probable that this is only a vague report. It is also said that a lump of gold ore was found near the falls of the river Rapahanoc, in Virginia, probably rolled down from its source, or that of some tributary rivulet. It is to be regretted that the government does not employ expert European miners to examine the countries where rich minerals are supposed to exist.

Copper ore is said to appear in Massachusetts, and in New Jersey a rich copper mine was long wrought, pretended to have been discovered by a flame visible in the night, like one of the gold mines in Hungary. This circumstance, sometimes authenticated, may arise from decomposing pyrites. Native copper is found on the river Tonnagan, which runs into Lake Superior*.

Lead is said to appear on the bank of the river Connecticut, two miles from Middleton, and is even said to have been wrought, but abandoned on account of the expence. Lead is also said to appear in the province of New York, but the materials in general supplied by Dr. Morse upon the important subject of mineralogy are brief, inexact, and unsatisfactory.

In the Shawangunk mountains, in New Hampshire, there is a considerable vein of lead ore, which appears to be accompanied with manganese.

The lead mines in Upper Louisiana have continued profitable for several years †. That called Burton's mine is thirty-eight miles to the west north west of St. Genevieve, where the mineral is supposed to extend over two thousand acres of land, and is of two kinds, gravel and fossil. "The gravel mineral is found immediately under the soil, intermixed with gravel, in pieces from one to fifty pounds weight of solid mineral. After passing through the gravel, which is commonly from three to four feet, is found a sand rock, which is easily broken up with a pick, and when exposed to the air, crumbles to a fine sand. This rock also continues five or six feet, and contains mineral nearly of the same quality as the gravel: but mineral of the first quality is found in a bed of red clay, under the sand rock, in pieces from ten to five hundred pounds weight, on the out-

* According to Imlay, p. 135, there is a very rich vein of copper on the river Wabash. Dr. Barton says, that a bed of cinnabar has been discovered in Virginia. Sulphur is found in New York and other parts. Plumbago, arsenic, and antimony, are observed in South Carolina.

† Message of the President, 1804, 8vo.

side of which is a white, gold or silver coloured spar or fossil, of a bright glittering appearance, as solid as the mineral itself, and in weight as three to two; this being taken off, the mineral is solid, unconnected with any other substance, of a broad grain, and what mineralogists call potters' ore. When it is smelted in a common smelting furnace, it produces sixty per cent. and when again smelted in a slag furnace, produces fifteen per cent. more; making, cleanly smelted, seventy-five per cent. The gravel mineral is incrustated with a dead grey substance, the eighth of an inch in thickness; has small veins of sulphur through it, and will not produce more than sixty per cent. when cleanly smelted."

In other mines, situated about thirty miles to the south-west of St. Genevieve, the lead is found in regular veins, from two to four feet in thickness, containing about fifty ounces of silver in the ton; but at the depth of twenty-five feet, the operations are impeded by water; in short, the mineral tract is here very extensive and rich, and the present produce is computed at more than forty thousand dollars annually. Before the cession of Louisiana, 1803, they had been worked by the French, but in a negligent and inefficient manner.

In Virginia there are said to be lead mines which yield from fifty to eighty pounds from one hundred of ore. This metal is also said to occur in South Carolina.

But the substances which are the most precious to industry are iron and coal. In the district of Main the founderies are supplied with bog ore; and another kind is found in great abundance in Massachusetts, where there are considerable manufactures. There is one mine not far from Boston of which the ore has a vitreous appearance, and is slightly magnetic; I believe the new metal discovered by Mr. Hatchet, is a specimen from Massachusett's. There are also mines of iron in Rhode Island, the middle states, and South Carolina. Pennsylvania abounds with this metal.

" Iron ore, in immense quantities, is found in various parts of this state (Massachusetts), particularly in the old colony of Plymouth, in the towns of Middleborough, Bridgewater, Taunton, Attleborough, Stoughton, and the towns in that neighbourhood, which have in consequence become the seat of the iron manufactures *. The

* Morse, 325. ed. 1794. 4to.

slitting mills, in this district, it is said, annually slit six hundred tons of iron; and one company has lately been formed, which will annually manufacture into nails, of a quality equal to those imported, five hundred tons of iron. The number of spikes and nails made in this state is supposed now to be twice as large as that made in 1788, and is still increasing, and will probably soon preclude all foreign importations, and, from the abundance of the raw material, may become an article of export."

The iron works on the river Pataxet, twelve miles from Providence, in Rhode Island, are supplied with ore from a bed four miles and a half distant, in a valley pervaded by a rivulet. A new channel has been formed for the water, and the pits are cleared by a steam engine. There are also many iron works in Maryland *.

Coal has been discovered in great abundance on both sides of James river, and is said to have been first observed by a boy in pursuit of cray fish. This valuable mineral also abounds towards the Mississippi and Ohio, that of Pittsburg being of a superior quality, but it is chiefly worked in Virginia, where the beds seem very extensive †. In the territory south of the Ohio, what is called stone coal is found in the Cumberland mountains.

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* Morse, 344. ed. 1794. 4to.

† In 1804 a coal mine was discovered on the river Juniata, twenty-five miles to the west of Huntingdon, Pennsylvania, and of course near the Apalachian mountains, which is now wrought with considerable advantage. The bed of coal is horizontal, and upwards of ten feet thick. The price at the mine is seven or eight cents per bushel, and there is an easy water carriage to Columbia. In Virginia a bed of coal, about twenty-four feet thick, has been found to rest on granite. Volney, 96.

The quantity of coal imported between the 1st of October 1800, and the 30th of September 1801, was,

In American bottoms . .	363,148 bushels
In foreign bottoms . .	301,911
Total	665,059

Of this the quantity brought from Great Britain makes a large proportion of the whole, viz.

From England	349,509 bushels
Scotland	233,553
Ireland	64,888

The remaining 17,109 come from the same countries, but by a circuitous route. At the rate then of 36 bushels to a chaldron, 18,473 chaldrons of British coal are annually consumed in the United States.

Plumbago, commonly called black lead, aluminous slate, and asbestos, are said to be found in Massachusetts.

Zinc appears in Connecticut and New York; gypsum is not unknown in New York. Limestone is rare on the east of the Blue ridge; but there is a vein of marble which crosses James river, and a long bed of lime-stone passes through North Carolina, in a south westwardly direction.

Diamond Hill, in Rhode Island, so called from its sparkling appearance, contains a variety of singular stones, but their nature has not been described. Talc is found in pretty large plates in Pennsylvania and New York; and appears in New Hampshire adhering to rocks of white or yellow quartz *. The largest leaves are found in a mountain about twenty miles to the east of Dartmouth college. The same author also informs us, that black lead is found in large quantities in the township of Jaffrey, in the southern part of the same state. Amethysts, or violet coloured crystals, are found in Virginia; and it is probable that the emerald mentioned by Mr. Jefferson was only a green crystal, though emeralds be also said to exist near Philadelphia. The diamonds of South Carolina are probably mere crystals of quartz. Georgia, the most southern state before the acquisition of Louisiana, is of a rich soil; but besides a bank of oyster-shells, ninety miles from the sea, there seems no mineralogic discovery †.

White pipe clay, with yellow and red ochre, have been found at Martha's vineyard, in Massachusetts.

It is said that Louisiana contains some mines of lead and iron, and even some appearances of silver, towards the Rio Colorado, or red river. During the Mississippi scheme, the rich silver mines of St. Barbe were held out as an inducement, but no certain evidence of their existence appears. In the map of Louisiana, by De Lisle, they are placed on the western side of the river Magdalena, whose mouth is indicated in the chart of the gulph of Mexico, recently published by the Spanish government ‡.

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* Belknap, vol. iii. p. 193.

† Oysters are however found in the rivers at a considerable distance from the sea, as appears from Mr. Weld and other authors.

‡ Near Frankstown, in Pennsylvania, is found the sulphated strontian of Haüy, crystalised in a fibrous mass of a celestial blue. In South Carolina, among the granitic mountains, is found the *epidote* of the same author, of a yellowish

SECTION V.

Metallic Mines of Great Britain and Ireland.

At Ecton Hill, close by the river Dove, a very valuable copper-mine was discovered about the year 1740. Some adventurers obtained from the Duke of Devonshire, to whom the estate belonged, a lease for twenty-five years, impowering them to search for copper, and they expended thirteen thousand pounds before any returns were made; but at length, at about two hundred yards deep, vast quantities of copper-ore were found, which increased as the descent was continued, and very considerable fortunes were acquired before the expiration of the lease; since which time the whole undertaking has vested in the duke, and the mine has continued to be worked to great advantage, clearing annually from eight to ten thousand pounds. In its position, situation, and inclination, it is different from any mine yet discovered in Europe, Asia, Africa, or America; the wonderful mass of copper-ore with which it is impregnated not running in regular veins or courses, but sinking perpendicularly down, widening and swelling out at the bottom in form of a bell. The works are a hundred and fifty yards below the bed of the river Dove, being the deepest mine in Great Britain. On the opposite side of Acton-hill is a valuable lead-mine, the veins of which ore approach very near to the copper.

On the island of Anglesea, near Dulas Bay, on the north coast, is Pary's Mountain, which contains the most considerable body of copper-ore perhaps ever known. The external aspect of the hill is extremely rude, and rises into enormous rocks of coarse white

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green; and in the county of Pendleton, the *titane oxidee*, or the third variety of the adamantine spar of Kirwan. *Walckenaer.*

The mountains near the pleasant village of Esopus, or Kingston, on the western side of the Hudson river, are said to contain a great variety of ores and fossils, among which are native alum and galena. At Marble Town, in the neighbourhood, are quarries of fine black marble, interspersed with shells. The mill-stones found near Esopus are used in many parts of the United States.

Fullers earth is found at the Washington mines, in Newfield, Massachusetts, whence it is conveyed to many parts of the United States, Vegetable impressions are found in lime-stone, in a hill half a mile west of Esopus, New Hampshire. The strata are from ten to twelve inches thick, of a blueish grey.

quartz. The ore is lodged in a bason, or hollow, and has on one side a small lake, over whose waters, as those of Avernus*, fatal to the feathered tribe, no bird is known to pass. The whole aspect of this track has, by the mineral operations, assumed a most savage appearance. Suffocating fumes of the burning heaps of copper arise in all parts, and extend their baneful influence for miles around. According to Pennant, the ore has been worked in a very remote period, and vestiges of the ancient operations appear in several parts, carried on by trenching, and heating the rocks intensely, then suddenly pouring on water so as to cause them to crack or scale. In the year 1768, after a long course of fruitless search, which was on the point of being abandoned, a large body of copper-ore was found, which has ever since been worked to great advantage, and still promises a vast supply. The water lodged in the bottom of the bed of ore, being strongly impregnated with the metal, is drawn up, and distributed into pits. A quantity of iron is immersed in this water, and the particles of copper are immediately precipitated, whilst the iron itself is gradually dissolved into a yellow ochre; great part of it floats off by the water, and sinks to the bottom. The pieces of iron-ore are frequently taken out, and the copper scraped off; and this is repeated until the whole of the iron is consumed. The copper thus procured differs little from native copper, and is prized accordingly, being sold at from 35l. to 45l. a ton. This kind of process has long been practised in the Wicklow mines of Ireland, and above a century in those of Herrengrund, in Hungary, where it is called *Ziment copper*. The waters of the Hungarian mines are much more strongly impregnated with copper than those of Parry's mountain. Eight tons of gunpowder are annually used for blasting the rock. Nature has been profuse in bestowing her mineral favours on this spot; for above the copper-ore, and not more than two-thirds of a yard beneath the common soil, is a bed of yellowish greasy clay, from one to four yards thick, containing lead ore, from a ton of which metal upward of fifty ounces of silver are generally obtained. These works have added greatly to the population of the country, for about fifteen hundred persons are employed, who, with their families, are supposed to make 8000 souls, that procure their subsistence from these mines; the chief

* See Chap. xxx. Sect. vii.

proprietor of which was the late Sir Nicholas Bailey, at whose death they descended to his nephew the Earl of Uxbridge.

No county in England is so advantageously situated for carrying on fisheries as that of Cornwall, and the inhabitants avail themselves fully of their local advantages. It however derives its chief importance from the different metals which the bowels of the earth contain; these, for the most part, consist of two sorts, one of tin, the other of copper; those of tin are very numerous, and are in general very large, and rich in ore, and have rendered Cornwall famous in all ages. There have also been sometimes found a small quantity of gold and silver, but not worthy of notice. With the metalline ores are intermixed large quantities of *mundic* and *arsenic*. Many sorts of stones are also found here, particularly the *moor-stone*, which is used both in buildings and for mill-stones. Its natural composition is very beautiful, consisting, for the greatest part, of a whitish granulated marble, variegated with a sort of black and yellow matter resembling tinsel and tin-glass, shining and glittering very agreeably in the sun-beams, This stone, therefore, while new, gives a glaring aspect to buildings; but though prodigiously hard at first, it soon loses its colour and consistence. When polished, it appears much more splendid and beautiful than any of the marble kinds, and makes the richest furniture, as tables, chimney-pieces, &c. but being exceedingly hard, the polishing is very expensive.

The TIN-WORKS are of different sorts, on account of the different forms in which the tin appears, for in many places its ore so nearly resembles common stones, that it can only be distinguished from them by its superior weight. Another form in which tin appears is that of tin and earth compounded and concreted into a substance almost as hard as stone, of a bluish or greyish colour, while often the mundic gives it a yellowish cast. This ore is always found in a continued stratum, which the tinners call *load;* and this, for the most part, is found running through the solid substance of the hardest rocks, beginning in small veins near the surface, perhaps not above half an inch or an inch wide, and increasing as they proceed into large dimensions, branching out into several ramifications, and bending downward in a direction that is in general nearly east and west. These loads are sometimes white, very wide, and so thick that large lumps of the ore are frequently drawn up of more than twenty pounds weight. The loads of tin-ore are not always conti-

guous, but sometimes break off so entirely, that they seem to terminate; but the sagacious miner knows by experience, that by digging a small distance on one side he shall meet with a separated part of the load appearing to tally with the other end, as nicely as if it had been broken off by some sudden shock of the rock.

The miners of this county follow the load in all its rich and meandering curves through the bowels of the rocky earth. Sometimes the waters are drained from these mines by subterraneous passages, formed from the body of the mountain to the level country; these are called *adits*, and occasionally prove the labour of many years; but when effected, save the constant expence of large water-works and fire-engines. From the surface of the earth they sink a passage to the mine, which they call a shaft, and over it place a large winch; but in greater works, a wheel and axle, by which means they draw up large quantities of ore at a time, in vessels called kibbuls. This ore is thrown into heaps, which great numbers of poor people are employed in breaking to pieces and fitting the ore for the stamping-mills.

A third form in which tin appears is that of crystals; for tin will, under proper circumstances, readily crystallise: and hence, in many parts of the mineral rocks, are found the most perfectly transparent and beautiful crystals of pure tin.

The Copper Mines of this county are very numerous, and some of them large, and rich in ore. It is remarkable, that in various parts of Cornwall the earth has produced such an exuberance of this metal, as to afford it in large massy lumps of malleable copper, several pieces of which they shew in very curious vegetable forms. The mundic, found in the loads of tin, was for many ages considered as of no other use but to nourish tin while in the mine. In the reign of Queen Elizabeth, a laudable curiosity prompted some private persons to examine into its nature, but the design miscarried, and the mundic was thrown as useless into the old pits with other rubbish; but about a hundred years ago, Sir Gilbert Clark began to work upon the mundic, and others following his example, have by degrees effected their purpose, and the copper extracted from this ore, once esteemed useless, now brings in above one hundred and fifty thousand pounds a year, and equals in goodness the best Swedish copper, yielding a proportionable quantity of *lapis calaminaris* for making brass.

In many of the cavernous parts of the rocks are found those transparent crystals called *Cornish diamonds*, they being extremely brilliant when well polished. Their form is that of a six-sided prism pointed on the top, and they are sometimes four or five inches in length.

All the parts of Cornwall on the north-east side of St. Austle's, St. Michael's, and St. Agnes, have little or no mineral ores, but mostly abound with rocks of blue slate, especially toward the south, where are many large quarries of that useful fossil. In Mount's Bay, near Penzance, the shore is, as it were, paved with rocky stone, of so fine a grain, that it equals any hone in giving an edge to a razor.

In Shropshire we trace mines of lead, copper, iron, limestone, freestone, pipe-clay, and inexhaustible coal-pits. Over most of the coal-pits lies a stratum of a blackish, hard, porous substance, containing great quantities of bitumen, which being ground to powder in horse-mills, and boiled in coppers of water, throws forth a bituminous matter on the surface, which, by evaporation, is brought to the consistence of pitch; or, by the help of an oil distilled from the same substance, and mixed with it, may be thinned to a sort of tar: both these substances serve admirably for caulking ships, and as well if not better than common pitch and tar, being less liable to crack.

In the same county, between two towering and variegated hills, covered with wood, on the banks of the Severn, is situated COLEBROOK DALE, where the largest iron works in England are now carrying on. The advantages, indeed, which this spot furnishes, are peculiarly great; for the ore is obtained from the adjacent hills, the coals from the vale, and abundance of limestone from the quarries in the neighbourhood. The romantic scenery which nature here exhibits, and the works which are carrying on, seems to realise the ancient fable of the Cyclops. "The noise of the forges, mills, &c." observes Mr. Young, "with all their vast machinery, the flames bursting from the furnaces, with the burning of coal, and the smoke of the lime-kilns, are altogether horridly sublime." To complete the peculiaries of this spot, a bridge, entirely constructed of iron, is here thrown over the Severn. In one place it has parted, and a chasm is formed; but such is its firm basis, that the fissure has neither injured its strength nor utility.

In considering the mineralogy of SCOTLAND, it may be premised, that a country so mountainous must be naturally expected to abound with metals, and some fortunate accident may, perhaps, discover in some of the skirts of the granitic chain, silver mines equal to those of Norway; for such discoveries arise not from a sedulous or skilful inquiry, but from the trifling accidents of a shower of rain, of a shepherd running after a goat, or the like. Mr. Kirwan has given an excellent account of the various substances in which metals are generally found *. In granitic mountains, tin, lead, iron, zinc, bismuth, cobalt; and in gneiss, or schistose granite, silver, copper, lead, tin and zinc. In micaceous schistus are found copper, tin, lead, antimony; in hornblende slate, copper ore; under argillate, or common slate, silver, copper, lead, zinc. In steatite, sulphureous pyrites, and magnet. In primitive lime-stone, appear, copper, lead, zinc; and even in strata of coal, have been found native silver, galena, and manganese. The small quantity of gold found in Scotland, has been procured from the Lead-hills, which are mostly composed of coarse slate. This precious metal first appeared in the sands of Elvan, a rivulet which joins the Clyde, near its source; and a place still exists, called Gold-scour, where the Germans used to wash the sand. None worth mentioning has been found recently. The silver generally accompanies lead; and in the rich mines of Saxony, the baser metals were found near the surface, but the richer at a great depth. The silver found in Scotland, has hitherto been of little account; the chief mine was that at Alva, which has since only afforded cobalt. Nor can Scotland boast of copper, though a small quantity was found in the Ochills, near Alva, with silver and cobalt; and it is said that the islands of Shetland offer some indications of that metal. Copper has also been found at Colvend in Galloway, at Curry in Lothian, at Oldwick in Caithness, and Kiffern in Rosshire.

The chief minerals of Scotland are lead, iron, and coal. The lead mines in the south of Lanerkshire, where the gold was also found, have been long known. Those of Wanlock-head, are in the immediate neighbourhood, but in the county of Dumfries. These two mines yield yearly above two thousand tons. The Susan-

* Geol. Ess. 428.

nah vein, Lead-hills, has been worked for sixty years, and produced vast wealth *. Some slight veins of lead have also been found in the western Highlands, particularly Arran. Iron is found in various parts of Scotland; the Carron ore is the most known, which Mr. Kirwan describes as being an argillaceous iron-stone, of a blueish grey, internally of a dark ochre yellow †. It is found in slaty masses, and in nodules, in an adjacent coal mine, of which it sometimes forms the roof. At the Carron-works, this ore is often smelted with the red greasy iron ore from Ulverston, in Lancashire, which imparts easer infusion, and superior value. Calamine, or zinc, is also found at Wanlock-head: and it is said, that plumbago and antimony may be traced in Scotland ‡.

But the chief mineral is coal, which has been worked for a succession of ages. Pope Pius II. in his Description of Europe, written about 1450, mentions that he beheld with wonder, black stones given as alms to the poor of Scotland. But this mineral may be traced to the twelfth century. The earliest account given of the Scottish coal mines is contained in a book, published by one George Sinclair, who calls himself Professor of Philosophy at Glasgow, but his name does not appear in the university list §. He explains, with some exactness, the manner of working coal; and mentions the subterraneous walls of whin which intersect the strata, particularly a remarkable one, visible from the river Tyne, where it forms a cataract, and passing by Prestonpans, to the shore of Fife. The observations of Mr. Williams on this subject, are given with much practical skill. The Lothians, and Fifeshire, particularly abound with this useful mineral, which also extends into Ayrshire; and near Irwin is found a curious variety, called ribbon coal. A singular coal,

* See Jars Voy. Met. who regards these as the richest mines of Europe. That of Arkingdale, in Yorkshire, is now the first in England.

† Min. vol. ii. 174.

‡ Plumbago is found in considerable quantities near Cumnock, in Ayrshire. It is said to be a continuation of a bed of coal, which, being intercepted by a vein of grunstein, changes to plumbago, which becomes the purer as it approaches nearer to the grunstein. This last substance and trap, or basalt, are in Scotland called *whin*, a word which is not much known to the mineralogists of Europe, but is obtaining an introduction into their nomenclature. Manganese is found in Aberdeenshire. It is also said that corundun has also been discovered in the same county.

§ Nat. Phil. improved by new exp. Edinb. 1683. Quarto, p. 258—302.

in veins of mineral, has been found at Castle Leod, in the east of Rosshire *.

In passing to the less important minerals of Scotland, we find at Strontian, in the district of Sunart, and parish of Ardnamurchan, Argyleshire, the new earth that, under the name of Strontian, has of late years been introduced into the systems of mineralogy and chemistry. Ben Nevis affords beautiful granite. Fine statuary marble is found in Assynt, and at Blair Gowrie, in Perthshire. A black marble, fretted with white like lace-work, occurs near Fort William; dark brown with white at Cambuslang, Clydesdale. Jasper is found in various parts; Arthur's seat offers a curious variety; and on the western shore of Icolmkill, are many curious pebbles, of various descriptions †. Fuller's earth is found near Campbeltown, in Cantire; and, it is supposed, that there must be a vast mass of talc, equal to that of Muscovy, in the mountains which give rise to the river Findorn, as large pebbles of it are sometimes found in that stream. Pearls have been occasionally found; but that any of the gems are found in Scotland, seems dubious. Quartz and fluor assume various hues; and what are called false sapphires, rubies, emeralds, &c. fall under one or other of these descriptions, while the real gems belong to the argillaceous class, and when examined with a microscope, are found to consist of minute layers, a form common to the argillaceous description ‡.

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* It is supposed that the largest untouched field of coal in Europe exists in Scotland, in that singular barren track of country in Carluke and Cambusnethan parishes, Lanerkshire, continuing with intervals to Douglas parish, to Glenbuck and Muirkirk, in Ayrshire, and thence to the town of Ayr. The Cleugh, or Wilson-town, in Lanerkshire, is the S. E. of this coal field, which is excluded by the Shot hills, but extends on the west along the bason of Clyde. This supply of coal would be of great importance, if it be true as it is conjectured by many persons, that all that exists between the Forth and the Esk will be exhausted in forty years.

See also two spirited and satisfactory pamphlets, by Stewart of Allanton, Edin. 1800, 8vo; whence it appears that this great coal tract extends like an isosceles triangle, the vertex being near Glasgow, and the base towards Carluke, the length being about twenty-two miles.

† Garnett's Tour.

‡ The mamelated ore of zinc is among the products of the Lead-hills. Hartfell is of primitive argillaceous schistus; its mineral water is vitriolated,

The mineralogy of IRELAND, has been recently ennobled by the discovery of considerable masses of native gold, in the county of Wicklow, to the south of Dublin. These were found in a brook, running west to east, to the river of Avonmore, where it is joined by the river Aghrim; and on the declivity of a mountain called Croaghan Kinshella, about seven English miles west of Arklow, and

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that of Moffat sulphurated. On the hill near Langholm are found masses of calcedony. Near Broxmouth is black marble, with large madrepores. Slates are worked near the Cairns Inn, Loch Ryan. At Frisky, twelve miles below Glasgow, there is an old wall composed of trap from the neighbouring hills, containing masses of beautiful prehnite. The rock of Dunbarton castle is trap.

Near Killicrankie is hornblend schistus. At Balmerino are found eyed agates on the shore in considerable quantities; the neighbouring rocks seem to contain those stones, as do those of Scot's craig, opposite to Dundee. Beautiful agates are also found in the river May, but the lapidaries of Edinburgh are chiefly supplied from the south bank of the river Esk, opposite Montrose. Near Aberdeen the granite is grey, but at Peterhead red. At Strontian were found zeolite and staurolite, but the last not in crosses. Loch Awe abounds in lapis ollaris, of which Kilchurn castle is built, and several ornamental tombs of this stone occur in the church-yard of Glenorchy, and in an isle in the lake. The western summit of Cruachan is red granite, and the upper part of the mountain is composed of large blocks of the same stone heaped together, a not unusual circumstance, granite being often in large rhomboidal divisions, and dividing easily by those natural seams. The only place in Scotland where flint seems to be found, is on the western side of the isle of Mull. Ulva presents columnar basalt. In Icolm Kill there is a stratum of white marble, of a schistose texture, containing steatite, which traverses the island from N. W. to S. E. the crosses are of gneiss, the causy of granite. Gypsum is rare in Scotland, but a small vein of the red kind is observabl en Campsey hills, near Dunbarton.

Stirling castle stands on grunstein, which has something of a columnar form, and decomposes in spheroidal strata. At Airthy is a copper mine worked at present. One of silver existed at Binny-craig, on the southern shore of the Forth. Pentland hills seem to be trap; that nearest Edinburgh, on the Linton road, is agate rock. Braid-hill and Blackford-hill are likewise trap, in the latter veins of jasp-agate and jasper. Craig Lockhart and Corstorphin hills are grunstein. The Castle-hill of Edinburgh black basalt with prehnite. Salisbury Craigs trap, grunstein of red felspar and black hornblend, jasper with spots of iron, &c. Calton-hill partly porphyry, light red spots upon a purplish ground; crystals are found of twenty-four sides, resembling leucite, but of a reddish colour. Inchcolm presents thin veins of fibrous green serpentine in a decomposed trap. Bass is of reddish trap; at the harbour of Dunbar is a causy formed by the extremities of hexagonal columns of a red stone (trap or jasper?) traversed by veins of a fine white hornstein. (See Pococke, Ph. Tr. lii.) Coal is only wrought in Scotland in the two basons of the Forth and the Clyde, including that of the Ayr.

six south-west of the noted copper mines of Cronbane*. It is said that a jeweller who lately died in Dublin, often declared that gold from that spot had passed through his hands to the value of 30,000 l. the secret being retained for many years, and some pieces weighing to the amount of seventy or eighty guineas. It is now worked for government, and it is said that a very massy vein has been recently discovered, which it is hoped will greatly benefit the country; for mines have in all ages, ancient and modern, enriched and improved the countries where they were found, and the exception, if such, of Spanish America, is to be assigned to causes of a different nature.

Gold is also reported to have been anciently found in the province of Ulster, in the sand of a rivulet called Miola, which falls into the north-west corner of the lake called Neagh †. As minute particles of gold are sprinkled through most regions of the world, so in some instances a few may find opportunities to combine, by the law of aggregate attraction, and thus excite notice without any chemical procedure. But to infer from such a discovery that considerable quantities of this precious metal must be found in the mountains, whence the streams have chanced to convey golden sand, or even small fragments, might only lead to rash and speculative adventure; for even in the favourite regions of native gold, it has sometimes been found that a river or rivulet had actually carried down what little gold originally existed in the mountain. Another consideration remains, well known in Peru and Hungary, namely, whether more gold may not be expended than procured, in working a mine, if virtually discovered.

The silver found in the Irish mines deserves more attention. Boate mentions a mine of this metal, intermingled with lead, which was wrought in the county of Antrim, and yielded a pound of pure silver from thirty pounds of lead. Another, less productive of silver, was found at Ballysadare, near the harbour of Sligo in Connaught; and a third in the county of Tipperary, thirty miles from Limerick. The ores of this last were of two kinds, most generally of a reddish colour, hard and glistering; the other, which was the richest in silver, resembled a blue marl. The works were destroyed in the Irish insurrections under Charles I. The mine, however, is now wrought on account of the lead it contains.

* Phil. Trans. 1797. † Boate, p. 69.

Copper ore is found in various parts of Ireland, and many of the mines contain evident marks of their having been wrought at a former period. That at Cronebane and Ballymurtagh, in the county of Wicklow, is of pyrites in argillate strata. It contains from seven to ten per cent. of copper; and when broken is sent to Swansea or Neath to be smelted. The separation of copper from its sulphate by means of iron is practised here to a great extent *. The Ballymurtagh mine was opened in 1755, by Mr. Whaley, who acquired a large property from it. In Ross island, in the lake of Killlarney, a copper mine is now working, where rich grey copper ore is procured in a matrix of quartz, having about thirty per cent. of the metal. At the same place are found native copper, ruby copper ore, malachite, and copper pyrites in great variety. The chief difficulty in procuring the ore arises from the water of the lake, which requires much labour to keep it out. There is also a copper mine on the opposite peninsula of Mucruss, which is not wrought at present. Near Newport, in the county of Tipperary, there is a rich mine of yellow pyrites, lately opened, which promises to be very profitable to those concerned in it.

One of the chief mineral productions of Ireland is iron, the mines of which were little known till the time of Elizabeth. Boate divides the iron mines of Ireland into three descriptions: 1. What he styles the bog mine, or what is now termed lowland ore, found in moors and bogs: the ore resembling a yellow clay, but mouldering into a blackish sand. 2. The rock mine, a bad sort, the ore intimately combined with stone. 3. That found in various mountains, the ore spheric, and of a whitish grey colour: balls of the best ore contained kernels full of small holes, whence the name honey-comb ore. Boate praises this iron as frequently rivalling that of Spain; and his work may be consulted for the manner of conducting the founderies.

Lead is found in great abundance at Donally, near silver mines, in the county of Tipperary, before mentioned; at Ross Island; near Cloghnakilty in the county of Cork; and in the county of Wexford. That at Ross Island is steel-grained galena, and has often veins of copper pyrites running through it. At Donalty, besides galena, there is very rich white lead-ore. Grey cobalt-ore is found at Mucruss in Kerry; and when the late Mr. Raspe was in

* Frazer's Statist. Account of Wicklow.

Ireland he found it used for repairing a road in the neighbourhood. There is also manganese and blende, both brown and black in great abundance, in various parts of the country.

The beds of coal to be seen in various regions of Ireland have not yet been explored to their proper extent. That at Kilkenny, found at Castlecomer, is deservedly celebrated among mineralogists, as the purest which has yet been traced in any quarter of the globe. Even as early as the time of Boate, coal was accidentally discovered in an iron mine, in the county of Carlow.

One of the most beautiful marbles of Ireland is found near Kilkenny; and others have been discovered in various parts of the island. Boate brands the freestone of Ireland as being liable to imbibe the moisture of the atmosphere; to prevent which effect it was necessary to incrust the walls with brick, or to line them with wainscot. Slate of various kinds is also abundant.

In the basaltic region of the county of Antrim, is a white limestone, which resembles chalk in many respects, especially in containing nodules of flint; but is much harder than chalk, from having a greater quantity of water of crystallization*. In the county of Clare has been found fluor resembling that of Derbyshire. Near Belfast is a large stratum of fine gypsum; and fuller's earth has been found in several counties of Ireland.

[*Pennant. Frazer. Phil. Trans. Pinkerton.*]

SECTION VI.

Quicksilver Mines at Idria, with the Story of Count Alberti's Imprisonment.

WE have purposely separated these extraordinary excavations from our general survey of mines of the European continent, that we might have an opportunity of introducing, in a more detached form, a very singular and interesting anecdote.

The Ban of Idria is a district immediately subject to the Chamber of Inner Austria; and lies towards the west of Krain or Carniola. The quicksilver mines of Idria are celebrated in natural history, poetry, and romance. The town is small, seated in a deep valley, amidst high mountains, on the river of the same name, and at the

* Mushet, in Philos. Mag.

bottom of a descent so steep, that it is very difficult, and sometimes dangerous, to ride to it. The town consists of about two hundred and seventy scattered houses, and a citadel; but the number of the inhabitants is calculated at about two thousand.

This town is famous for its quicksilver-mines, which were first discovered in the year 1497. Before that time, says Keyster, this part of the country was only inhabited by a few coopers, and other artificers in wood, with which the country abounds. But one evening a cooper having placed a new tub under a dropping spring, to try if it would hold water, when he came in the morning to take the tub away, found it so heavy that he could hardly move it. At first, the superstitious notions that are apt to possess the minds of the ignorant, made him begin to suspect that his tub was bewitched; but at last perceiving a shining fluid at the bottom, and not knowing what to make of it, he went to Laubach, where he shewed it to an apothecary, who being an artful man, dismissed him with a small gratuity, and bid him bring some more of the same stuff whenever he could meet with it. This the poor cooper frequently did, being highly pleased with his good luck; till the affair being at last made public, several persons formed themselves into a society, in order to search farther into the quicksilver-mine. In their possession it continued till Charles Duke of Austria, perceiving the great importance of such a work, gave them a sum of money, as a compensation for the expences they had been at, and took it into his own hands.

The subterraneous passages of the mine are so extensive, that it would take up several hours to go through them. The greatest perpendicular depth, computing from the entrance of the shaft, is eight hundred and forty feet; but as they advance horizontally under a high mountain, the depth would be much greater if it were measured from the surface of the hill. One way of descending the shaft is by a bucket; but as the entrance is narrow, the bucket is liable to strike against the sides, or to be stopped by something in the way, so that it may easily overset. A second way of going down is safer; which is, descending by a great number of ladders, placed obliquely, in a kind of zig-zag; but as the ladders are wet and narrow, a person must be very cautious how he steps, to prevent his falling. In the course of the descent, there are resting places in different parts, that are very welcome to the weary tra-

veller. In some of the subterranean passages the heat is so intense, as to throw a man into a sweat; and formerly, in some of these shafts, the air was extremely confined, so that several miners have been suffocated by a kind of igneous vapour called the damp; but by sinking the main shaft deeper, this has been prevented. Near the main shaft is a large wheel, and an hydraulic machine, by which all the water is raised out of the bottom of the mine.

The mercury prepared by nature, or perfectly pure, is called Virgin Metal, and is found in some of the ores of this mine, in a multitude of little drops of pure quicksilver. This is also to be met with in a kind of clay, and sometimes flows down the passages or fissures of the mine in a small continued stream, so that a man has frequently gathered in six hours above thirty-six pounds of virgin mercury, which bears a higher price than common quicksilver. The rest is extracted from cinnabar (which is the ore of quicksilver) by the force of fire.

Every common miner receives the value of three shillings and six-pence a-week; but many of them are afflicted with a paralytic disorder, accompanied with violent tremblings, sudden convulsive motions of the hands and legs, and frightful distortions of the face. Those are most subject to these disorders who work in the places where virgin-mercury is found, which in a surprising manner insinuates itself into their bodies; so that when they go into a warm bath, or are put into a profuse sweat by steam, drops of pure mercury have been known to issue through the pores from all parts of the body. These mines are often infested with rats and mice, which feed on the crumbs of bread, &c. dropped by the miners at their meals. But this plague seldom lasts long; for even these animals are seized with the convulsive maladies as well as the miners, which soon proves fatal to them. It is esteemed a necessary precaution for every person to eat before he descends into these subterraneous regions.

All the adjacent country is very woody; but that the woods may not be destroyed, great quantities of fuel for the smelting furnaces are annually brought down the river Idra, or Idrizza, from forests that lie about five or six miles distant. Beside this river, is a canal about two miles in length, supplied with water by several streams issuing from perennial springs, in order to put in motion the machines belonging to the mines.

To these pernicious and deadly caverns criminals are occasionally banished by the Austrian government: and it has sometimes occurred, that this punishment has been allotted to persons of considerable rank and family. The following is a most interesting instance of this kind related not many years ago by Mr. Everard, then in Italy, in two letters to a friend, inserted in the tenth volume of the Annual Register, and which has laid a foundation for Mr. Sargent's elegant dramatic poem, from this circumstance entitled *The Mine.*

LETTER I.

THE pleasure I always take in writing to you, wherever I am, and whatever doing, in some measure dispels my present uneasiness; an uneasiness caused at once by the disagreeable aspect of every thing round me, and by the more disagreeable circumstances of the Count Alberti, with whom you were once acquainted. You remember him one of the gayest, most agreeable persons at the court of Vienna; at once the example of the men, and the favourite of the fair sex. I often heard you repeat his name with esteem, as one of the few that did honour to the present age; as possessed of generosity and pity in the highest degree; as one who made no other use of fortune, but to alleviate the distresses of mankind. That gentleman, Sir, I wish I could say is now no more; yet, too unhappily for him, he exists, but in a situation more terrible than the most gloomy imagination can conceive.

After passing through several parts of the Alps, and having visited Germany, I thought I could not well return home without visiting the quicksilver mines at Idria, and seeing those dreadful subterraneous caverns, where thousands are condemned to reside, shut out from all hopes of ever seeing the cheerful light of the sun, and obliged to toil out a miserable life under the whips of imperious task-masters. Imagine to yourself an hole in the side of a mountain, of about five yards over; down this you are let in a kind of bucket, more than a hundred fathom, the prospect growing still more gloomy, yet still widening, as you descend. At length, after swinging in terrible suspense for some time in this precarious situation, you at last reach the bottom, and tread on the ground; which, by its hollow sound under your feet, and the reverberations of the echo, seems thundering at every step you take. In this gloomy and

frightful solitude, you are enlightened by the feeble gleam of lamps, here and there disposed, so as that the wretched inhabitants of these mansions can go from one part to another without a guide. And yet let me assure you, that though they by custom could see objects very distinctly by those lights, I could scarce discern, for some time, any thing, not even the person who came with me to shew me these scenes of horror.

From this description, I suppose you have but a disagreeable idea of the place; yet let me assure you, that it is a palace, if we compare the habitation with its inhabitants. Such wretches my eyes never beheld. The blackness of their visages only serves to cover an horrid paleness, caused by the noxious qualities of the mineral they are employed in procuring. As they in general consist of malefactors condemned for life to this task, they are fed at the public expence; but they seldom consume much provision, as they lose their appetites in a short time, and commonly in about two years expire, from a total contraction of all the joints of the body.

In this horrid mansion I walked after my guide for some time, pondering on the strange tyranny and avarice of mankind, when I was accosted by a voice behind me, calling me by name, and enquiring after my health with the most cordial affection. I turned, and saw a creature, all black and hideous, who approached me, and with a most piteous accent demanding, "Ah! Mr. Everard, "don't you know me?" Good God! what was my surprise, when through the veil of his wretchedness I discovered the features of my old and dear friend Alberti! I flew to him with affection, and, after a tear of condolence, asked how he came there. To this he replied, that having fought a duel with a General of the Austrian infantry, against the Emperor's command, and having left him for dead, he was obliged to fly into one of the forests of Istria, where he was first taken, andafterwards sheltered, by some banditti, who had long infested that quarter. With these he had lived for nine months, till, by a close investing of the place in which they were concealed, and after a very obstinate resistance, in which the greater part of them were killed, he was taken and carried to Vienna, in order to be broke alive upon the wheel. However, upon arriving at the capital, he was quickly known; and several of the associates of his accusation and danger witnessing his innocence, his punishment of the rack was changed into that of perpetual confinement

and labour in the mines of Idria: a sentence, in my opinion, a thousand times worse than death.

As Alberti was giving me this account, a young woman came up to him, who at once I saw to be born for better fortune: the dreadful situation of the place was not able to destroy her beauty; and even in this scene of wretchedness, she seemed to have charms to grace the most brilliant assembly. This Lady was in fact daughter to one of the first families of Germany; and having tried every means to procure her lover's pardon without effect, was at last resolved to share his miseries, as she could not relieve them. With him she accordingly descended into these mansions, from whence few of the living return; and with him she is contented to live, forgetting the gaieties of life; with him to toil, despising the splendors of opulence, and contented with the consciousness of her own constancy.

LETTER II.

DEAR SIR,

My last to you was expressive, and perhaps too much so, of the gloomy situation of my mind. I own the deplorable situation of the worthy man described in it, was enough to add double severity to the hideous mansion. At present, however, I have the happiness of informing you, that I was spectator of the most affecting scene I ever yet beheld. Nine days after I had written my last, a person came post from Vienna to the little village near the mouth of the greater shaft: he was soon followed by a second, and he by a third. Their first enquiry was after the unfortunate Count; and I, happening to overhear the demand, gave them the best information. Two of these were the brother and cousin of the Lady; the third was an intimate friend and fellow-soldier to the Count: they came with his pardon, which had been procured by the General with whom the duel had been fought, and who was perfectly recovered from his wounds. I led them with all the expedition of joy down to his dreary abode, and presented to him his friends; and informed him of the happy change in his circumstances. It would be impossible to describe the joy that brightened in his grief-worn countenance: nor was the young Lady's emotion less vivid at seeing her friends, and hearing of her husband's freedom. Some hours were employed in mending the appearance of this faithful couple; nor could I

without a tear behold him taking leave of the former wretched companions of his toil. To one he left his mattock, to another his working clothes, to a third his little household utensils, such as were necessary for him in that situation. We soon emerged from the mine, when he once again revisited the light of the sun, that he had totally despaired of ever seeing. A post-chaise and four were ready the next morning to take them to Vienna; where, I am since informed by a letter from himself, they are returned. The Empress has again taken him into favour; his fortune and rank are restored; and he and his fair partner now have the pleasing satisfaction of feeling happiness with a double relish, as they once knew what it was to be miserable.

By way of appendix, though it does not fall immediately within the range of the present chapter, we shall add from Mr. Sargent's translation the following interesting account recorded by Diodorus Siculus of the wretchedness of the criminals who were formerly condemned to work at the mines in Egypt.

"On the confines of Egypt, Arabia, and Ethiopia," says Diodorus Siculus, "there is a tract of land abounding with minerals, and particularly with gold, which is extracted with infinite labour and expence. The soil, which is hard and black, is intersected with veins of marble of the most brilliant whiteness and lustre. In this spot the superintendants of the mines employ a great number of workmen to procure the ore; for the kings of Egypt send all those persons to the mines who have been convicted of any crime, as well as the prisoners taken in war, and every one who, being falsely or justly accused, has incurred their resentment. Their families are often involved in the same fate; and their sovereign, by these means, not only satisfies his vengeance, but derives a great advantage from their punishment. These unhappy persons, the number of whom is very considerable, have chains fastened upon their legs, and are condemned to toil day and night without intermission, or any hope of escaping from their wretchedness: for they have foreign soldiers set over them, who speak a different language from themselves, which renders it impossible for them to corrupt their guards, either by familiarity or promises. When the soil which contains the ore is too hard, they soften it by fire; after which they apply their manual exertions, and break it in pieces with iron tools adapted to that purpose. A skilful person superintends the business, who is

acquainted with the veins of the mine, and directs the workmen to them. The strongest prisoners are employed to cleave the rocks with sharp iron mallets; a work which demands only bodily strength, and no superior dexterity. They drive their wedges obliquely, as they are directed by the glimmering of the ore; and as it is often necessary to make sudden turns to follow the veins of the mineral, and because the subterraneous cavities in which they work are extremely dark, they have lamps affixed to their foreheads. By varying their posture as often as their situation requires it, they break off the pieces of rock, which fall down at their feet. In this manner they toil incessantly, being compelled by the menaces and the stripes of their task masters. Into the smaller cavities of the rock little children are sent, who extract from thence the minute pieces of ore, and convey them to the mouth of the mine. The men of about thirty years of age have a certain quantity of the mineral given them, which they pound in mortars with iron pestles, and reduce to the size of a grain of millet. The women and old men then receive it, and placing it under grind-stones, which are ranged in order for that purpose, they dispose of themselves two or three to each mill, and grind it till they have reduced it to the fineness of meal, of which they have a sample given them. It is impossible not to compassionate the extreme misery of these wretches, who are not permitted to bestow any care on their persons, nor to cover their nakedness. No mercy is at any time shewn either to the sick or maimed, to the weakness of the female sex, or the debility of age; but they are compelled by stripes to persevere, till their strength is exhausted, and they expire with fatigue. Thus these unfortunate people have no hope but in death, and the horrors of their situation make them dread the prolongation of life.—The superintendants, who take the ore when it is reduced to a fine powder, finish their work in the following manner: They spread it upon planks a little inclined, and wash it copiously with water. The earthy particles are thus carried away by the force of the stream, while the gold, on account of its weight, is left behind. This operation being frequently repeated, they rub the ore lightly between their hands; after which they dry it with fine sponges, till all impurity is removed, and the powder is perfectly clean. Other workmen then take it, and having weighed and measured it, put it into earthen pots. A certain proportion of lead is afterwards added to it, with

a few grains of salt, a little tin, and some barley meal. They pour the whole into covered vessels, exactly luted, which they place in a furnace for five days and nights successively: then, having allowed it time to cool, no further mixture of impure matter is found, but the gold is entirely purified, with very little waste. Such is the manner in which they obtain gold on the confines of Egypt, with immense labour. Thus Nature herself points out with what great difficulty the acquisition of this metal is attended; which, when procured, can only be retained by extreme caution and diligence; and the use of which is productive of so much delight and solicitude!"

[*Diodorus Siculus. Sargent. Ann. Reg. Scopali Tentamen de Minera Hydrargyri.*]

SECTION VII.

Coal Mines.

COALS are scattered with a more or less sparing hand over every continent, and almost over every kingdom of the globe; but in no country are coal-mines so rich and frequent as in our native soil. M. Faujas de St. Fond has ascribed the whole opulence of England to her coals, as being the very soul of her manufactures, and consequent commerce. The coals of Whitehaven and Wigan are more pure; and the cannel and peacock coals of Lancashire are so beautiful, that they are suspected by some to have constituted the *gagates*, or jet, which the ancients ascribed to Britain. It is occasionally met with, as at Bovey-heath in Devonshire, resembling wood impregnated with bituminous matter of turf or peat, we have already spoken of in describing the fens and mosses of the country, and we find it extending even to Hampshire and other southern districts.

There is, indeed, nothing which has contributed more essentially to the prosperity of Great Britain, or, which has tended more to produce and foster the important manufactures, by which this industrious and enterprizing island is distinguished, than the mines of coal, which are scattered in such profusion under its surface. We find every manufacturing town set down in the midst of a coal country: Bristol, Birmingham, Wolverhampton, Sheffield, Newcastle, and Glasgow, afford striking instances, and many more will readily occur to the recollection of every one who is acquainted with

Great Britain. An accurate account of the different coal fields, in this island, would be a very valuable addition to our geognostic knowledge. Several excellent tracts on the subject have been published at different periods, especially by Mr. Williams, in his *Mineral Kingdom*; but, unfortunately, the terms employed in these tracts, being the usual ones employed by the miners, are too vague and too little understood to convey any exact information. There is a paper in an early volume of the Transactions, giving an account of the coal mines of Mendip, in Somersetshire. They occur in that county, as every where else in the low country, and are not to be found in the hills. The beds of coal are not horizontal, but sloping, and they dip to the south-east at the rate of about 22 inches per fathom. Hence they would speedily sink so deep that it would not be possible to work them, were it not that the beds are here and there intersected by perpendicular dykes, or veins, of a different kind of mineral, (sometimes clay, but usually green stone): and, upon the other side of this vein, they are all found considerably raised up. There are seven different beds of coal at Mendip, lying at regular distances below each other, and separated by beds of a different kind of matter. From the names which Mr. Strachey applies to these beds, it is impossible to make out the nature of every mineral which occurs. Sand stone, slate slay, and bituminous shale, seem to be the principal. The deepest bed of coal, which is ten inches thick, and is not considered as worth working, lies about 38 fathoms, or 228 feet below the surface of the earth *.

The town of Newcastle, in the county of Northumberland, is very much distinguished for its trade in coals. It was first made a borough by William the Conqueror, and the first charter granted to the townsmen for digging coals was in the reign of Henry III. in the year 1239; but in 1306, the use of coal for fuel was prohibited in London, by royal proclamation, chiefly because it injured the sale of wood for fuel, great quantities of which were then growing about that city. This interdiction, however, did not long continue, and we may consider coals as having been dug and exported from this place for more than four hundred years. According to Pennant, there are about twenty-four considerable collieries which lie at different distances, from five to eighteen miles, of the river. Brand

* Phil. Trans. 1719. Vol. XXX. p. 968.

makes the average of six years to Christmas 1776, produce an annual consumption of three hundred and eighty thousand chaldrons, Newcastle measure, of which about thirty thousand chaldrons are exported to foreign parts. The boats employed in the colliery are called keels, and they are described by Mr. Pennant as strong, clumsy, and oval, each carrying about twenty tons, and about four hundred and fifty of such keels being constantly employed. The keelmen are those who load and unload the boats or lighters: they were formed into a fraternity as early as the year 1539; and seem to have been dependant on the hostmen, who were incorporated in 1600, but their employment is not ascertained by Mr. Brand; probably they acted as agents in freighting the ships which came to that port for coals, which they obtained from the proprietors of the coal-mines. Pennant, who gives a somewhat different estimate, states the shipping at Newcastle in the year 1776 to be as follows:

	Ships.	Tons.
Coast trade - - - - - - -	3585	689,090
Foreign ports - - - - - - -	363	49,124
Total	3948	738,214

It is a common opinion among geologists, that pit coal is of vegetable origin, and that it has been brought to its present state by means of some chemical process, with which we are still unacquainted. There is one circumstance which gives this opinion, though at first sight it may appear extravagant, considerable plausibility, we mean, the existence of vast depositions of matter, half way as it were between perfect wood and perfect pit coal; betraying obviously its vegetable nature, and yet so nearly approximating to pit coal in several respects, that it has been generally distinguished by the name of coal. One of the most remarkable of these depositions exists in Devonshire, about 13 miles south-west of Exeter, and is well known under the name of Bovey coal. It has been very well described by Dr. Mills, in the Philosophical Transactions; and its vegetable nature has been ascertained by Mr. Hatchett, in a set of experiments which do not belong to the present chapter.

The beds of coal are 70 feet thick, but there are beds of clay interspersed. On the north side they come within a foot of the surface, and dip south at the rate of about 20 inches per fathom.

The deepest beds are the blackest and heaviest, and have the closest resemblance to coal. The upper resemble wood strongly, and are considered as wood by the people who dig them. They are brown, and become exceedingly friable when dry. They burn with a flame similar to wood. They have exactly the appearance of wood which has been rendered quite soft by some unknown cause, and, while in this state, has been crushed flat by the weight of the incumbent earth. This is the case, not only with Bovey coal, but it holds also with all the beds of wood coal, hitherto observed in every part of the earth. Dr. Mills and Dr. Miller have endeavoured, by subjecting Bovey coal to destructive distillation, and comparing the effects with the destructive distillation of wood, to prove, that it has not been formed from the vegetable kingdom, but that it is purely and originally a mineral *. But their arguments are not only inconclusive, but inconsistent with many circumstances connected with the coal. Mr. Hatchett found both *extractive* and *resin*; substances peculiar to the vegetable kingdom.

The most extraordinary excavations that are perhaps any where to be met with are at Whitehaven, and they seem to have a very considerable resemblance in their structure to the gypsum quarries at Paris, whence many have conceived that the latter are in like manner altogether artificial. The following description of this extraordinary colliery we take from Nicholson's Antiquities of Westmoreland.

The coal mines at this place (Whitehaven) are perhaps the most extrardinary of any in the known world. Sir John Lowther, father of the late Sir James, was the first that wrought them for foreign consumption. It hath been computed, that the said two gentlemen, in the compass of a century (which time they enjoyed these mines), expended in one of them only, upwards of half a million sterling.

The principal entrance into these mines for men and horses, is by an opening at the bottom of an hill, through a long passage hewn in the rock; which, by a steep descent, leads down to the lowest vein of coal. The greatest part of this descent is through spacious galleries, which continually intersect other galleries; all the coal being cut away except large pillars, which, in deep parts of the mine, are three yards high, and about twelve yards square at the

* Phil. Trans. 1760. Vol. LI. p. 534 and 941.

base; such great strength being there required to support the ponderous roof.

The mines are sunk to the depth of one hundred and thirty fathoms, and are extended under the sea to places where there is, above them, sufficient depth of water for ships of large burden. These are the deepest coal mines that have hitherto been wrought; and perhaps the miners have not in any other part of the globe penetrated to so great a depth below the surface of the sea; the very deep mines in Hungary, Peru, and elsewhere, being situated in mountainous countries, where the surface of the earth is elevated to a great height above the level of the ocean.

There are here three strata of coal, which lie at a considerable distance one above another, and there is a communication by pits between one of these parallel strata and another. But the vein of coal is not always regularly continued in the same inclined plain, but instead thereof, the miners meet with hard rock, which interrupts their further progress. At such places there seem to have been breaks in the earth, from the surface downwards; one part of the earth seeming to have sunk down, while the part adjoining hath remained in its ancient situation. In some of these places the earth may have sunk ten or twenty fathoms or more; in other places, less than one fathom. These breaks, the miners call Dykes; and when they come at one of them, their first care is to discover whether the strata in the part adjoining be higher or lower than in the part where they have been working; or (to use their own terms) whether the coal be cast down, or cast up. If it be cast down, they sink a pit to it; but if it be cast up to any considerable height, they are oftentimes obliged, with great labour and expence, to carry forward a level or long gallery through the rock. until they again arrive at the stratum of coal.

Those who have the direction of these deep and extensive works, are obliged with great art and care to keep them continually ventilated with perpetual currents of fresh air; which afford the miners a constant supply of that vital fluid, and expel out of the mines damps and other noxious exhalations, together with such other burnt and foul air, as is become poisonous and unfit for respiration.

In the deserted works, which are not ventilated with perpetual currents of fresh air, large quantities of these damps are frequently collected; and, in such works, they often remain for a long time,

without doing any mischief. But when, by some accident, they are set on fire, they then produce dreadful explosions, very destructive to the miners; and bursting out of the pits with great impetuosity, like the fiery eruptions from burning mountains, force along with them ponderous bodies to a great height in the air.

The coal in these mines hath several times been set on fire by the fulminating damp, and hath continued burning for many months; until large streams of water were conducted into the mines, and suffered to fill those parts where the coal was on fire. By such fires, several collieries have been entirely destroyed; of which there are instances near Newcastle, and in other parts of England, and in the shire of Fife in Scotland; in some of which places, the fire has continued burning for ages.

In order to prevent, as much as possible, the collieries from being filled with those pernicious damps, it has been found necessary carefully to search for those crevices in the coal, from whence they issue out; and at those places, to confine them within a narrow space; and from those narrow spaces in which they are confined, to conduct them through long pipes into the open air; where being set on fire, they consume in perpetual flames, as they continually arise out of the earth.

The late Mr. Spedding, who was the great engineer of these works, having observed that the fulminating damp could only be kindled by flame, and that it was not liable to be set on fire by red hot iron, nor by the sparks produced by the collision of flint and steel, invented a machine, in which article a steel wheel is turned round with a very rapid motion, and flints are applied thereto, great plenty of fiery sparks are emitted, that afford the miners such a light as enables them to carry on their work in close places, where the flame of a candle, or lamp, would occasion dreadful explosions. Without some invention of this sort, the working of these mines, so greatly annoyed with these inflammable damps, would long ago have been impracticable.

But not so many mines have been ruined by fire as by inundations. And here that noble invention the fire-engine displays its beneficial effects. It appears, from pretty exact calculations, that it would require about 550 men, or a power equal to that of 110 horses, to work the pumps of one of the largest fire-engines now in use (the diameter of whose cylinder is seventy inches), and thrice that num-

ber of men to keep an engine of this size constantly at work: And that as much water may be raised by an engine of this size kept constantly at work, as can be drawn up by 2520 men with rollers and buckets, after the manner now daily practised in many mines; or as much as can be born up on the shoulders of twice that number of men, as is said to be done in some of the mines of Peru. So great is the power of the elastic steam of the boiling water in those engines, and of the outward atmosphere, which by their alternate actions give force and motion to the beam of this engine, and by it to the pump rods, which elevate the water through tubes, and discharge it out of the mine.

There are four fire engines belonging to this colliery; which, when all at work, discharge from it about 1228 gallons every minute, at thirteen strokes; and after the same rate 1,768;320 gallons every twenty-four hours. By the four engines here employed, nearly twice the above-mentioned quantity of water might be discharged from mines that are not above sixty or seventy fathoms deep, which depth is rarely exceeded in the Newcastle collieries, or in any of the English collieries, those of Whitehaven excepted.*

Coal pits have sometimes taken fire by accident, and have continued to burn for a considerable length of time. There is one example of this accident, related in two different papers in the Philosophical Transactions. About the year 1648, a coal mine at Benwell, a village near Newcastle-upon-Tyne, was accidentally kindled by a candle; at first, the fire was so feeble, that the reward of half-a-crown, which was asked by a person who offered to extinguish it, was refused. But it gradually increased, and had continued burning for thirty years when the account, in the Transactions, was drawn up; and, it was not conceived, that it ever could be extinguished till the fuel was burnt out †. Other examples, of a similar kind, have happened in Scotland and in Germany.

[*Faujas de St. Fond. Pennant. Nicholson and Burn. Thomson.*]

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* For these observations, observes Mr. Nicholson on the coal mines at Whitehaven, we are obliged to the very ingenious Dr. Brownrigg's Notes on a beautiful little poem of Dr. Dalton's, on the return of two young ladies from viewing those mines.

† Phil. Trans. 1675. Vol. XI. p. 762; and Ibid. 1746, Vol. XLIV. p. 221.

SECTION VIII.

Felling Colliery, near Sunderland.

With an Account of the dreadful Accident which happened there on May 25, 1812.

FELLING is a manor in the chapelry of Heworth, and parish of Jarrow, about a mile and a half east of Gateshead, in the county of Durham. It contains several strata of coal, the uppermost of which were extensively wrought in the beginning of the last century. The stratum called the High-main, was won in 1779, and continued to be wrought till the 19th of January, 1811, when it was entirely excavated.

The present colliery is in the seam called the Low-main. It commenced in October, 1810, and was at full work in May, 1811. Messrs. John and William Brandling, Henderson, and Grace, have each a fourth share, both in its royalty and in the adventure; they have also a lease from the Dean and Chapter of Durham, of a large extent of coal, lying on the south and east of the manor of Felling.

The working or down-cast shaft, marked A on the annexed plan, is called the John Pit, and is situated on the north side of the Sunderland road, and half way between Felling toll-bar, and Felling-hall. It is 204 yards deep, and furnished with a machine or steam-engine for drawing the coal, and with an engine called a whim gin, wrought by horses, and of use in letting down and drawing up the workmen, when the machine chances to be crippled, or repairing; and when it lies idle on pay Saturdays and on Sundays. Here is also a high tube of brick-work, employed in assisting ventilation while this shaft was sinking, and till the communication by the narrow boards and the drifts was opened between the two shafts; since that it has been of no use.

The up-cast, or air furnace shaft, is called the William Pit. It is on an eminence 550 yards south-west of the John Pit, and is distinguished by a whim gin and a lofty tube of brick-work. This shaft is 232 yards deep.

Over each pit two iron pullies were suspended on a kind of scaffold, called the shaft-frame. In these ran the ascending and descending ropes. The pullies over the John Pit were six feet in diameter, and weighed nine cwt. a-piece. Those in which the rope of the gin were

John Pit ran, were fixed on a crane, which turned them over or from the shaft as occasion required.

As there are no feeders of water in the strata below the high main, the low main coal is kept perfectly dry by tubbing the watery seams with a circular casing of oak wood, formed into pieces resembling the fellies of a wheel: this contrivance has the appearance of the ashlar work of a well, and saves the expense of a steam-engine for drawing water. The white lines on the plan represent the excavated parts; the broadest of them are called boards, and these that cross them at right angles are walls. The two narrow lines which run north and south, on the east side, are called double winning head-ways, and the narrow lines between them, stentings; the two lines on the west side of the William Pit are also double winning head-ways. The two boards on the north are termed the narrow boards; they were the parts first excavated, and were made for the purpose of opening a communication for the atmospheric air between the two pits: the lines between the west end of the narrow boards and the William Pit, are called drifts. The inclined plane board is marked P P on the plan.

The parallelograms formed by the boards and walls, are called pillars; they are solid masses of coal left to support the roof of the mine, and are each twenty-six yards long, and eight yards broad.

The single black lines in the walls and stentings represent stoppings, and the double lines trap-doors, each of which are placed to divert the current of atmospheric air through proper channels. The stoppings are made of brick and lime; and in this colliery, were strengthened on each side with a wall of stone. The trap-doors are made of wood: each of them is attended by a boy about seven' eight, or ten years old; and they are seldom used but in the avenues leading from the working shaft to the workings. At the circle N, the air crossed the waggon-way, and at M, the way to the stable, over arches of brick. The walls which have stoppings in them, are called sheth-walls, and those that are open, loose-walls.

In all large colleries the air is accelerated through the workings, by placing a large fire, sometimes at the bottom, and sometimes at the top or the up-cast shaft, which in these cases is covered over and connected with a furnace tube or chimney, by an arched gallery of brick from 40 to 60 feet in length. In this colliery the furnace was about six feet from the bottom of the tube.

The first course of the air, after descending the John Pit, was under the arch M, up the inner narrow board and the stable board S, to the trap-door at the head of the narrow boards; then down the board next south of the stable board; and so afterwards up two boards and down other two, till it traversed the newly formed sheth or set of workings, branching from the southernmost part of the double-headways on the east: from thence it passed over the two arches up the outer board of the narrow boards, to the most westerly sheth of boards, and after fanning them, found its way down the crane board, along the drift to the William Pit, through which it ascended into the furnace, and thence, charged with noxious vapours, into the open air.

From this explanation it will easily be perceived that the purity and wholesomeness of a coal mine has no reference to its depth. If the air be conducted through all parts of a mine, as here described, and no falls from the roof occur to prevent its visiting every corner, the old excavations, which are called wastes, will be constantly ventilated by as pure air as the boards in which the men are at work—each part of the mine will be uniformly wholesome; but when obstructions occur, and are not speedily removed; when the fire in the furnace shaft is neglected; or when care has not been taken to place the stoppings and trap-doors in proper places, or the trap-doors are carelessly left open, or stoppings fall down,—in all these cases accumulations of fire-damp* (called *stythe* by the colliers), immediately

* What is called fire-damp in coal mines is the carbureted hydrogen gas of chemists, as has been sufficiently ascertained by direct experiments. It is composed of

Carbon	72
Hydrogen	28
	100

or of two atoms of hydrogen, and one of carbon. It is said, and perhaps truly, that it always exists in coal-mines, mixed with carbonic acid; and all the specimens of it procured for the purpose of examination, contain a mixture of that gas. Hence, probably, that fire-damp is formed by the action of coal upon water. The water is decomposed, two atoms at once. All the oxygen combines with carbon, and forms carbonic acid; while all the hydrogen unites likewise with carbon, and forms carbureted hydrogen, or fire-damp.

It is difficult, if not impossible, to make any mixture of fire-damp and common air explode. It only burns rapidly, with a blue flame, and little noise; but

commence in places deprived of the atmospheric current, and continue to train their dreadful artillery, and grow strong in danger, till the waste-men, or ventilators of the mine, discover them, and wash them off, or they ignite at the workmen's candles. Blasts occurring in partial stagnations, as in the face of one or two boards, though they generally scorch the persons in their way, seldom kill them; but when the air has proceeded lazily for several days through a colliery, and an extensive magazine of fire-damp is ignited in the wastes, then the whole mine is instantly illuminated with the most brilliant lightning—the expanded fluid drives before it a roaring whirlwind of flaming air, which tears up every thing in its progress, scorching some of the miners to a cinder, burying others under enormous heaps of ruins shaken from the roof, and, thundering to the shafts, wastes its volcanic fury in a discharge of thick clouds of coal dust, stones, timber, and not unfrequently limbs of men and horses.

But this first, though apparently the most terrible, is not the most destructive effect of these subterraneous thunderings. All the stoppings and trap-doors of the mine being blown down by the violence of the concussion, and the atmospheric current being for a short time

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when mixed with oxygen gas in the proper proportion, it explodes with great violence. Suppose we take 100 measures of pure carbureted hydrogen gas, it will not explode unless the oxygen present amount to 105 measures, and it ceases to explode whenever the oxygen amounts to more than 227 measures. Hence it would seem that whenever the fire-damp in mines amounts to 1-12th of the bulk of common air present, it will be apt to explode with a candle; and that whenever it exceeds 1-6th of the air, it will no longer be capable of exploding. All proportions between 1-6 and 1-12 will explode.

We are not acquainted with any means of preventing the formation of this gas; but it certainly might be prevented from accumulating, by ventilating the mine properly. If the usual method of fires, &c. be insufficient, nothing would be easier than to pump the air out of the mine, by means of an engine; and this would secure a perfect ventilation at all times, unless we suppose the workmen culpably negligent. It would be adviseable that the overseers of coal-mines, where fire-damp exists, should learn the method of analysing the air of the mine, in order to know when the fire-damp approaches to 1-12th of the air, that they might be aware of their danger, and have it in their power to take the requisite precautions to prevent it. The process to be followed is very simple: it would not require any expensive apparatus, and might be perfectly learned in two or three days by any intelligent person; and hence with great ease and certainty all accidents from fire-damps might be effectually guarded against.

entirely excluded from the workings, those that survived the discharge of the fire-damp, are instantly suffocated by the after-damp, which immediately fills up the vacuum caused by the explosion.

This after-damp is called choak damp and surfeit by the colliers, and is the carbonic acid gas of chemists. While the mine is at work, it lies sluggishly upon its floor, and suffers the atmospheric air, as a lighter fluid, to swim upon it; fire-damp being the lightest of the three, floats upon the atmospheric air, and therefore occupies a space, according to its present quantity, nearest the roof of the mine.

The coals from the boards on each side of the William Pit, were conveyed in strong wicker baskets called corves, to the crane, on trams, a narrow frame-work of wood mounted on four low wheels: this work was done by barrowmen and putters, some of whom are men, and manage a tram singly, by going behind it and pushing it forward; these are called hewing putters or headsmen: the others are two to a tram, and are called headsmen and foals, the former of whom pull before at a rope they call a soam, and the latter push behind with their shoulders: boys about 15 or 16 years old are employed in this department of the colliery. The crane, at the time of the accident, stood eleven pillars up the crane-board: it had been removed from the several pillars which have their uppermost corner canted off, and a period fixed in the vacancy. The use of the crane is to lift the loaden corves off the trams, upon waggons which differ little from the trams, except in their being larger and stronger. From the crane, about four waggons, each carrying two corves and chained together, were taken to the bottom of the crane-board near number 86, by the machine, called an inclined plane, which draws up the empty waggons by the weight of the loaded ones: the person who regulates this machine is called a brake-man. From the bottom of the inclined plane, the coals were conveyed on the same waggons to the John Pit.

This mine was considered by the workmen a model of perfection in the purity of its air, and ordinary arrangements—its inclined plane was saving the daily expense of at least 13 horses—the concern wore the features of the greatest possible prosperity, and no accident, except a trifling explosion of fire-damp, slightly burning two or three workmen, had occurred. Two shifts or sets of men were constantly employed, except on Sundays. Twenty-five acres of coal had been excavated. The first shift entered the mine at four o'clock, A. M. and were relieved at their working posts by the next at 11 o'clock

in the morning. The establishment it employed under ground, as will be seen in the succeeding narrative, consisted of about 128 persons, who, in the fortnight from the 11th to the 25th of May, 1812, wrought 624 scores of coal, equal to 1300 Newcastle chaldrons, or $2455\frac{20}{36}$ London chaldrons.

About half past eleven o'clock on the morning of the 25th of May, 1812, the neighbouring villages were alarmed by a tremendous explosion in this colliery. The subterraneous fire broke forth with two heavy discharges from the John Pit, which were, almost instantaneously, followed by one from the William Pit. A slight trembling, as from an earthquake, was felt for about half a mile around the workings; and the noise of the explosion, though dull, was heard to three or four miles distance, and much resembled an unsteady fire of infantry. Immense quantities of dust and small coal accompanied these blasts, and rose high into the air, in the form of an inverted cone. The heaviest part of the ejected matter, such as corves, pieces of wood, and small coal, fell near the pits; but the dust, borne away by a strong west wind, fell in a continued shower from the pit to the distance of a mile and a half. In the village of Heworth, it caused a darkness like that of early twilight, and covered the roads so thickly, that the footsteps of passengers were strongly imprinted in it. The heads of both the shaft-frames were blown off, their sides set on fire, and their pullies shattered in pieces; but the pullies of the John Pit gin, being on a crane not within the influence of the blast, were fortunately preserved. The coal dust, ejected from the William Pit into the drift or horizontal parts of the tube, was about three inches thick, and soon burnt to a light cinder. Pieces of burning coal, driven off the solid stratum of the mine, were also blown up this shaft.

As soon as the explosion was heard, the wives and children of the workmen ran to the working-pit. Wildness and terror were pictured in every countenance. The crowds from all sides soon collected to the number of several hundreds, some crying out for a husband, others for a parent or a son, and all deeply affected with an admixture of horror, anxiety, and grief.

The machine being rendered useless by the eruption, the rope of the gin was sent down the pit with all expedition. In the absence of horses, a number of men, whom the wish to be instrumental in rescuing their neighbours from their perilous situation, seemed to supply with strength proportionate to the urgency of the occasion, put their

shoulders to the starts or shafts of the gin, and wrought it with astonishing expedition. By twelve o'clock, 32 persons, all that survived this dreadful calamity, were brought to day-light. The dead bodies of two boys, numbers 1 and 4 *, who were miserably scorched and shattered, were also brought up at this time: three boys, viz. numbers 2, 3, and 5, out of the 32 who escaped alive, died within a few hours after the accident. Only 29 persons were, therefore, left to relate what they observed of the appearances and effects of this subterraneous thundering: 121 were in the mine when it happened, and 87 remained in the workings. One overman, two wastemen, two deputies, one headsman or putter (who had a violent tooth-ache), and two masons, in all eight persons, came up at different intervals, a short time before the explosion.

They who had their friends restored, hastened with them from the dismal scene, and seemed for a while to suffer as much from the excess of joy as they had lately done from grief; and they who were yet held in doubt concerning the fate of their relations and friends, filled the air with shrieks and howlings; went about wringing their hands; and threw their bodies into the most frantic and extravagant gestures.

The persons who now remained in the mine, had all been employed in the workings to which the plane-board was the general avenue, and as none had escaped by that way, the apprehension for their safety began to strengthen every moment. At a quarter after twelve o'clock, Mr. Straker, Mr. Anderson, William Haswell, Edw. Rogers, John Wilson, Joseph Pearson, Henry Anderson, Michael Menham, and Joseph Greener, therefore descended the John Pit, in expectation of meeting with some of them alive. As the fire damp would have instantly ignited at candles, they lighted their way by steel-mills, small machines which give light by turning a plain thin cylinder of steel against a piece of flint. Knowing that a great number of the workmen would be at the crane when the explosion happened, they attempted to reach it by the plane-board: but their progress was intercepted at the second pillar by the prevalence of choak-damp: the noxious fluid filled the board between the roof and the thill; and the sparks from the steel fell into it like dark drops of blood. Being, therefore, deprived of light, and nearly poisoned for want of atmospheric air, they retraced their steps to the shaft, and with similar

* The numbers refer to the situations of the sufferers in the annexed Plan of Felling Colliery.

success attempted to pass up the narrow boards: in these they were stopped at the sixth pillar by a thick smoke, which stood like a wall the whole height of the board. Here their flint-mills were not only rendered useless, and respiration became extremely difficult, but the probability of their ever reaching the places where they expected to meet with those they were in search of, or of finding any of them alive, was entirely done away. To the hopelessness of success in their enterprize should also be added, their certainty of the mine being on fire, and the probability of a second explosion at every moment occurring and burying them in its ruins.

At two o'clock Mr. Straker and Mr. Anderson had just ascended the John Pit, and were gone to examine the appearance of the air issuing from the William Pit. Menham, Greener, and Rogers, had also ascended. Two of the party were at this moment in the shaft, and the other two remained below, when a second explosion, much less severe than the first, excited more frightful expressions of grief and terror amongst the relatives of the persons still in the mine. Rogers and Wilson, the persons in the shaft, experienced little inconvenience by the eruption: they felt an unusual heat, but it had no effect in lifting up their bodies, or otherwise destroying the uniformity of the motion of their ascent. Haswell and H. Anderson, hearing its distant growlings, laid themselves down at full length on their faces, and in this posture, by keeping firm hold of a strong wooden prop, placed near the shaft, to support the roof of the mine, experienced no other inconvenience from the blast, than its lifting up their legs and poising their bodies in various directions, in the manner the waves heave and toss a buoy at sea. As soon as the atmospheric current returned down the shaft, they were drawn to bank.

This expedient of lying down and suffering the fury of the blast to roll over them, is mentioned in the Life of Lord Keeper North, under the year 1676. It is most efficacious where the mine is wet, for atmospheric air always accompanies running water; but the warning of a blast being usually sudden, it requires a degree of experience and coolness, not commonly united, to exercise any precaution against it. The miner knowing its irresistible power, instantly sees the inefficacy of every attempt to escape, and, like a physician attacked by some incurable complaint, and, conscious that his art is unequal to its cure, makes no struggle to save his life.

As each of the party came up, he was surrounded by a group of anxious inquirers. All their reports were equally hopeless; and the

second explosion so strongly corroborated their account of the impure state of the mine, that their assertions for the present seemed to be credited. But this impression was only momentary. On recollection, they remembered that persons had survived similar accidents, and when the mine was opened, been found alive. Three had been shut up during forty days in a pit near Byker, and all that period had subsisted on candles and horse beans. Persons, too, were not wanting to infect the minds of the relatives of the sufferers with disbelief in the accounts of the persons who had explored the mine. It was suggested to them, that want of courage or bribery, might be inducements to magnify the danger, and represent the impossibility of reaching the bodies of the unfortunate men. By this species of wicked industry, the grief of the neighbourhood began to assume an irritable and gloomy aspect. The proposition to exclude the atmospheric air from the mine, in order to extinguish the fire, was therefore received with the cries of "Murder," and with determinations of opposing the proceeding.

Many of the widows continued about the mouth of the John Pit during the whole of Monday night, with the hope of hearing the voice of a husband or a son calling for assistance.

On Tuesday the 26th of May, the natural propension of the human mind to be gratified with spectacles of horror was strongly exemplified. An immense crowd of colliers from various parts, but especially from the banks of the river Wear, assembled round the pits, and were profuse in reproaches on the persons concerned in the mine for want of exertion to recover the men. Every one had some example to relate of successful attempts in cases of this kind,—all were large in their professions of readiness to give assistance; but none were found to enter the inflammable jaws of the mine. Their reasonings and assertions seemed indeed to be a mixture of those prejudices and conceits which cleave to workmen whom experience has afforded a partial insight into the nature and peculiarities of their profession, and not to be grounded on any memory of facts, or to result from a knowledge of the connection between causes and effects: and on this account, as soon as the leaders of the outcry could be brought to listen with patience to a relation of the appearances that attended this accident, and to hear the reasons assigned for the conclusion that the mine was on fire, and that the persons remaining in were dead, they seemed to allow the impracti-

cability of reaching the bodies of the sufferers, till the fire was extinguished, and consequently the necessity of smothering it out by excluding atmospheric air from the mine.

The proprietors of the mine gave the strongest assurances to the crowd, that if any project could be framed for the recovery of the men, no expence should be spared in executing it; if any person could be found to enter the mine, every facility and help should be afforded him; but, as they were assured by the unanimous opinion of several of the most eminent viewers in the neighbourhood, that the workings of the mine were in an unapproachable state, they would hold out no rewerd for the attempt: they would be accessary to no man's death by persuasion or a bribe.

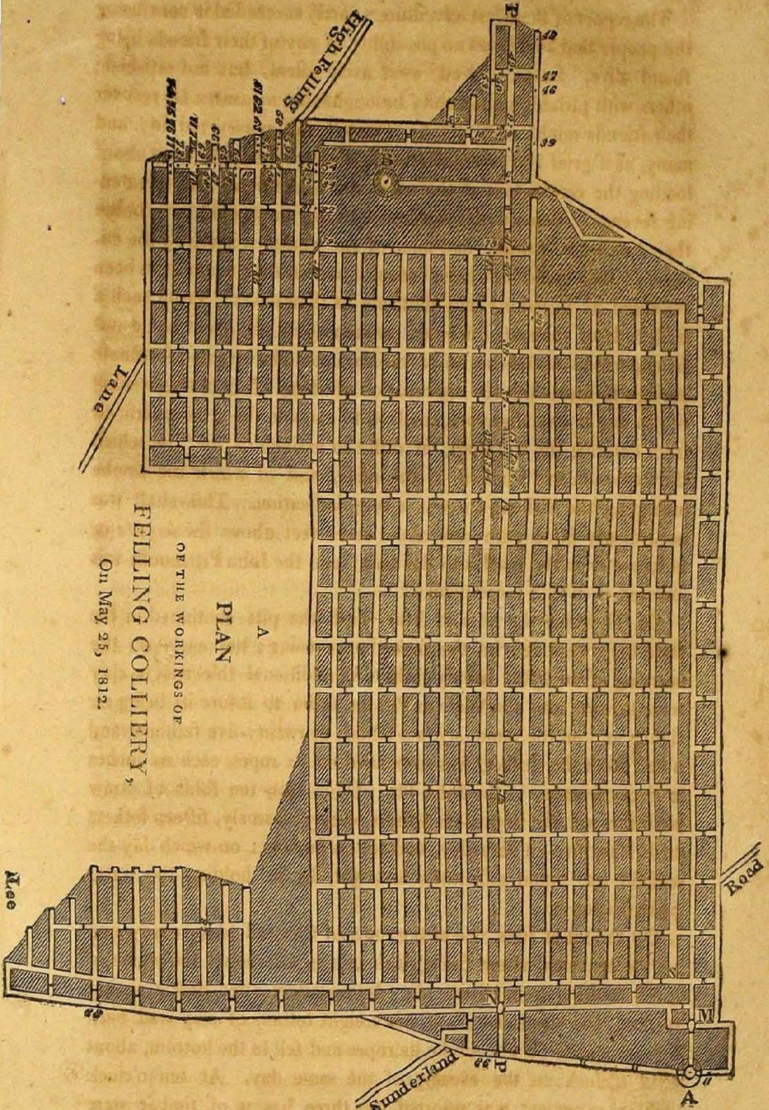
The mouth of the John Pit had continued open since the accident; the William Pit was to-day almost wholly muzzled with planks.

On Wednesday the 27th of May, at the clamorous solicitation of the people, Mr. Straker and the overman again descended the John Pit, in order to ascertain the state of the air in the workings. Immediately under the shaft they found a mangled horse, in which they supposed they perceived some signs of life; but they had only advanced about six or eight yards, before the sparks of the flint were extinguished in the choak-damp, and Haswell, who played the mill, began to show the effects of the carbonic poison, by faultering in his steps. Mr. Straker therefore laid hold of him, and supported him to the shaft. As the baneful vapours had now taken possession of the whole of the mine, and they found it difficult to breathe even in the course of the full current of the atmospheric air, they immediately ascended. But the afflicted creatures, still clinging to hope, disbelieved their report. Wishful, therefore, to give as ample satisfaction as possible to the unhappy women, Mr. Anderson and James Turnbull (a hewer of the colliery, who had escaped the blast) again went down. At thirty fathoms from the bottom they found the air exceedingly warm: to exist without apoplectic symptoms for more than a few yards round the bottom of the shaft, was found impossible, and even there the air was so contaminated, as to be nearly irrespirable. When they ascended, their clothes emitted a smell somewhat resembling the waters of Gilsland and Harrowgate, but more particularly allied to that of the turpentine distilled from coal tar.

The report of these last adventurers partly succeeded in convincing the people that there was no possibility of any of their friends being found alive. Some, indeed, went away silent, but not satisfied; others with pitiable importunity besought that measures to recover their friends might even yet be adopted and persevered in; and many, as if grief and rage had some necessary connection, went about loading the conductors of the mine with execrations, and threatening revenge. Some were even heard to say they could have borne their loss with fortitude had none of the workmen survived the calamity: they could have been consoled had all their neighbours been rendered as miserable and destitute as themselves! From such a multitude of distracted women, unanimity of sentiment could not be expected—no scheme of proceedings could be invented fortunate enough to meet with the approbation of them all. In the evening of this day it was, therefore, resolved to exclude the atmospheric air from entering the workings, in order to extinguish the fire which the explosion had kindled in the mine, and of which the smoke ascending the William Pit was a sure indication. This shaft was accordingly filled with clay about seven feet above the *ingate* or entrance from the shaft into the drift; and the John Pit mouth was covered over with loose planks.

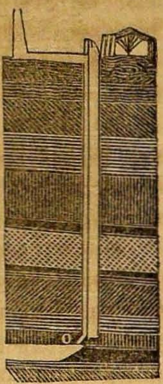
On Thursday the 28th of May, both the pits continued in the state they were left on the preceding evening; but early on the morning of the 29th, twenty fothers of additional thickness in clay were thrown into the William Pit, in order to insure its being air tight; and on the same day, a scaffold, at twenty-five fathoms and a half from the surface, was suspended on six ropes, each six inches in circumference, in the John Pit. Upon this, ten folds of straw were thrown, and twenty-six fothers of clay; namely, fifteen fothers on Friday, five on Saturday, and six on Sunday; on which day the scaffold was found sufficiently air tight, by its holding the water poured upon it.

On the 1st of June, one of the ropes of the scaffold gave way, and on the next day, about five o'clock in the afternoon, the whole of it fell to the bottom of the pit. Immediately after this a second scaffold was suspended; but when eight fothers of clay had been thrown upon it, it also broke its ropes and fell to the bottom, about eight o'clock on the evening of the same day. At ten o'clock another expedient was resorted to: three beams of timber were



A
PLAN
OF THE WORKINGS OF
FELLING COLLIERY,
On May 25, 1812.

laid across the mouth of the shaft, a little below the surface, and these were traversed with strong planks, upon which, on that evening, and early next morning, a body of clay was laid four feet thick, and firmly beaten together. At the same time a ten inch stopping of brick and lime was put into the tube drift of this shaft: this drift had long been closed, but the additional stopping was added, for greater security against the fire-damp escaping.



Preparations now began to be made for re-opening the mine. For this purpose a brattice or partition of thin deals, began to be put down the William Pit; of which and its furnace-tube and whim-gin, the annexed figure is a section. The black line down the shaft represents the brattice, which, in this case, was made to assist the workmen in raising the clay thrown down the shaft on the 7th and 29th of May.

About this time many idle tales were circulated through the country concerning several of the men finding their way to the shafts, and being recovered. Their number was circumstantially told—how they subsisted on candles, oats, and beans—how they heard the persons, who visited the mine on the day of the accident, and the Wednesday following, but were too feeble to speak sufficiently loud to make themselves heard. Some conjurer, too, it was said, had set his spells and divinations to work, and penetrated the whole secrets of the mine. He had discovered one famishing group receiving drops of water from the roof of the mine—another eating their shoes and clothes, and other such pictures of misery. These inventions were carefully related to the widows, and answered the purpose of every day harrowing up their sorrows afresh. Indeed, it seemed the chief employment of some to make a kind of insane sport of their own and their neighbours' calamity.

On the 19th of June, it was discovered that the water oozing out of the tubbing of the William Pit, had risen to the height of 24 feet upon the clay. On the 3d of July, this being all overcome, the brattice finished, and a great part of the clay drawn up, the sinkers began to bore a crow-hole at O, out of the shaft into the north drift. On the next day, the stoppings in the tube drift of the John Pit were taken down, and the bore-hole finished, through

which the air passed briskly into the mine, and ascended by the John Pit tube.

Some experiments made on the fire-damp, by collecting it in bladders in the John Pit tube, before the bore-hole was opened, proved that it would not ignite previous to its mixture with atmospheric air. This shaft became an up-cast at three in the afternoon of the 5th of July; at seven on the same day, the fire-damp exploded on its being exposed to the flame of a candle. From the 6th to the 8th, it continued in the same state, and after that became so saturated with atmospheric air, as to lose that property.

On the 7th of July, the workmen pierced through the clay in the William Pit into the drift; and at 45 minutes past eleven in the morning, the John Pit tube emitted a thick continued volume of vapour, alternately of a blackish and a grey colour; at five in the afternoon, it was of a light steam colour, and the next morning scarcely visible.

The morning of Wednesday the 8th of July, being appointed for entering the workings, the distress of the neighbourhood was again renewed at an early hour. A great concourse of people collected—some out of curiosity—to witness the commencement of an undertaking full of sadness and danger—some to stir up the revenge and aggravate the sorrows of the relatives of the sufferers, by calumnies and reproaches, published for the sole purpose of mischief; but the greater part came with broken hearts and streaming eyes, in expectation of seeing a father, a husband, or son, "brought up out of the horrible pit!"

As the weather was warm, and it was desirable that as much air might pass down the shaft as possible, constables were placed at proper distances, to keep off the crowd. Two surgeons were also in attendance, in case of accidents.

At six o'clock in the morning, Mr. Straker, Mr. Anderson, the overman of the colliery, and six other persons, descended the William Pit, and began to traverse the north drift towards the plane board. As a current of water had been constantly diverted down this shaft for the space of ten hours, the air was found to be perfectly cool and wholesome. Light was procured from steel-mills. As the explosion had occasioned several *falls* of large masses of stone from the roof, their progress was considerably delayed by removing them. After the plane-board was reached, a stopping

was put across it on the right hand, and one across the wall opposite the drift. The air, therefore, passed to the left, and number *six* was found.

The *shifts* of men employed in this doleful and unwholesome work, were generally about eight in number. They were four hours in and eight hours out of the mine: each individual, therefore, wrought two shifts every 24 hours.

When the body of number six was to be lifted into a shell or coffin, the men for a while stood over it in speechless horror; they imagined it was in so putrid a state, that it would fall asunder by lifting. At length they began to encourage each other "in the name of God" to begin; and after several hesitations and resolutions, and covering their hands with oakum to avoid any unpleasant sensation from touching the body, they laid it in a coffin, which was conveyed to the shaft in a bier made for the purpose, and drawn 'to bank' in a net made of strong cords.

It is worthy of remark that number six was found within two or three yards of the place where the atmospheric current concentrated, as it passed from the one pit to the other; but that he was lying on his face with his head downwards, apparently in the position into which he had been thrown by the blast. The air visited him in vain.

When the first shift of men came up, at ten o'clock, a message was sent for a number of coffins to be in readiness at the pit. These being at the joiner's shop, piled up in a heap, to the number of 92, (a most gloomy sight) had to pass by the village of Low Felling. As soon as a cart load of them was seen, the howlings of the women, who had hitherto continued in their houses, but now began to assemble about their doors, came on the breeze in slow fitful gusts, which presaged a scene of much distress and confusion being soon exhibited near the pit; but happily, by representing to them the shocking appearance of the body that had been found, and the ill effects upon their own bodies and minds, likely to ensue from suffering themselves to be hurried away by such violent convulsions of grief, they either returned to their houses, or continued in silence in the neighbourhood of the pit.

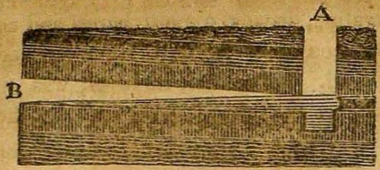
Every family had made provision for the entertainment of their neighbours on the day the bodies of their friends were recovered; and it had been generally given out that they intended to take the bodies into their own houses. But Dr. Ramsay having given his

opinion that such a proceeding, if carried into effect, might spread putrid fever through the neighbourhood, and the first body, when exposed to observation, having a most horrid and corrupt appearance, they readily consented to have them interred immediately after they were found. Permission, however, was given to let the hearse, in its way to the chapel-yard, pass by the door of the deceased.

From the 8th of July to the 19th of September, the heart-rending scene of mothers and widows examining the putrid bodies of their sons and husbands, for marks by which to identify them, was almost daily renewed; but very few of them were known by any personal mark—they were too much mangled and scorched to retain any of their features. Their clothes, tobacco-boxes, shoes, and the like, were, therefore, the only indexes by which they could be recognized.

After finding numbers *seven*, *eight*, and *nine*, the operations of the first day ceased, about ten o'clock in the evening. At six the next morning the workmen began to put deal stoppings into the stentings of the double head-ways west of the William Pit. In the afternoon number *ten* was found, and the third board south of the plane-board discovered to be much fallen: carrying a brattice nearly to its face was the last proceeding of the 9th.

Early in the morning of the 10th of July the air in the William Pit was discovered to be casting up with a current so feeble as nearly to approach to stagnation. This being supposed to be caused by the water collected about the bottom of the John Pit approaching the roof of the mine, the machine was put in readiness for drawing it. A collection of water amounting to about 4500 gallons was twice a week raised from a *sump* or well, immediately under the John Pit shaft. This sump was made for the purpose of receiving it as it oozed from the tubbing. The dip of this colliery being about one yard in twelve to the south-west, the lowest part of the colliery was consequently at this shaft, and the little water that the mine produced collected here. The double head-way was nearly water-level. The annexed section may assist in giving a clear idea of the appearance of the water when the circulation of air through the mine began to stop. A represents the shaft, and B the inner narrow-board.



Hitherto the air had descended into the mine by the John Pit tube: but now the clay laid over the mouth of this pit on the evening of the 1st of June was removed, and the *settle boards*, or frames, upon which the corves are loaded, were refixed. At 45 minutes after four o'clock this afternoon the water began to be drawn in buckets, each containing 90 gallons: 30 buckets were drawn in an hour.

On the morning of the 11th a larger stream of water than had been hitherto used was diverted down the William Pit, with the expectation of forcing the air to descend with it. This was a desirable point to effect, as the bodies of the sufferers might be more readily obtained by this pit than the other; but as the water fell about the John Pit the atmospheric current set more strongly down it: the attempt was therefore abandoned as hopeless.

The machine was constantly at work drawing water till Monday the 13th, when the rubbish occasioned by the falling of the two scaffolds on the 1st of June, stones blown from the roof by the blast, and the body of a horse, began to be raised. As the body of the boy number 11 had lain a long time in water it was perfectly white.

On Tuesday the 14th of July, as the workmen were clearing out the water-sump at the bottom of the John Pit, a gust of fire-damp burst from the workings, and ascended the shaft. This caused so great an alarm that the cry "Send away a loop!" from the bottom, and "Ride away! Ride away!" from the banksmen, were heard together. Seven of the men clung to the rope, and arrived safe at bank; and two old men threw themselves flat upon their faces, in expectation of an explosion; but, after a second and similar eructation, the atmospheric current took its usual course. No alteration was perceived at the William Pit. This phenomenon was afterwards ascertained to proceed from a large fall at that time taking place in

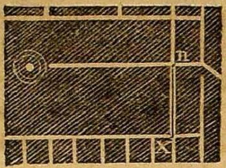
the stable board, and forcing back a foul admixture of the two damps and common air. The banksmen's cry so alarmed the villages of High and Lower Felling that all the inhabitants, young and old, hastened to the pit. At two o'clock in the afternoon the work was resumed.

On the 15th of July the bottom of the plane-board was reached, where the body of a mangled horse and four waggons were found. Though these waggons were made of strong frames of oak, strengthened with hoops and bars of iron, yet the blast had driven both them and the horse with such violence down the inclined plane-board that it had twisted and shattered them as if they had been shot from a mortar against a rock. Number 12, though a putter, at the time of the accident was employed at the meetings of the inclined plane, to keep the ropes in order as the waggons passed each other. Number 13, from the position in which he was found, seemed as if he had been asleep when the explosion happened, and had never after opened his eyes. He was seen about a quarter before eleven o'clock smoking his pipe on the place where his body was found. He attended to the five horses, and had the charge of keeping the waggon and inclined-plane ways free from obstructions.

After obtaining number 14 the crane was visited. Here 21 bodies, from number 15 to 36, lay in ghastly confusion; some like mummies, scorched as dry as if they had been baked. One wanted its head, another an arm. The scene was truly frightful. The power of the fire was visible upon them all; but its effects were extremely various: while some were almost torn to pieces there were others who appeared as if they had sunk down overpowered with sleep.

From an apprehension that the great body of fire-damp confined by the stoppings newly put into the walks immediately south of the plane-board, might burst forth if kept perfectly tight, the atmospheric air was thrown into the full-way board by a stopping placed across the plane-board, a little above the crane. As soon as numbers 42, 43, and 44, were coffined, the air was conducted to number 45. After this the stopping above the crane was taken down, and the workmen were employed from the night of the 18th to the morning of the 22d of July, in making a brattice from the north-west corner of the fourth right-hand pillar above the crane, to the south-east corner of the pillar next above the drift to the William Pit. By this contrivance the fire-damp on the south side of the plane-board was

not only pent in by two rows of stoppings above the crane, but it was left at liberty to escape into the drift on the south side of the brattice represented by the line x n in the annexed figure.



July the 22d. Nnmbers 46 and 47, as well as 39, had probably attempted to make their escape from the blast. They were lying on their faces, their heads downwards, and their hands spread forwards. 46 was working with 48; and 39, 47, 49, and 50, were blasting stone from the roof at 49.

Little progress was made on the 23d; for after 51 was found, the day was chiefly spent in removing two heavy falls under which 52 and 53 were buried. The last of these had his employment in the second board south of the plane-board; he had therefore at the time of the accident either not commenced his work, or left it to talk with the young men at 49.

About ten o'clock this evening the piece of solid coal between the face of the first board south of the William Pit, and the double head-ways on the west of it, began to be pierced. After being bored through with a miner's auger, the hole was kept perfectly tight by a wooden plug, while a passage for the men was opened. Iron picks were used till the coal was thin, when it was battered down in the dark with a wooden prop. Then picks of oak and lignum vitæ, hardened in the fire, were used in widening the avenue; and the steel-mills not suffered to play till the air took a regular suck past 54, 79, 78, and behind the brattice, x n into the William Pit drift. This work was finished a little after twelve o'clock.

Before two o'clock in the morning of the 24th, number 54 was reached. It is worthy of remark that nearly the whole of the men found in this line of boards had fallen on the very spot where they were employed. In the progress of obtaining the bodies from 54 to 60, nothing particular occurred except a large fall, under which number 59 was found.

On the 25th of July, eleven bodies, from 61 to 71, were interred Number 64 was under a large fall. This man was keeper of the Heworth poor house, and a class-reader of the Wesleyan sect of Methodists. A pamphlet has been published, containing twenty-four pages, and entitled "A short Account of the Life and Christian Experience of John Thompson, &c. compiled chiefly from his own Journal. By Theophilus Lessey. Newcastle-upon-Tyne, printed by J. Marshall, 1812. The profits of this pamphlet it is intended to apply to the relief of his widow and five orphan children.

The bodies of 59 and 64 were the only ones fallen in this sheth; each board here was bratticed nearly to its face, more with a view of rendering them pure and clean, than of giving assistance in obtaining the bodies; for the workmen, out of anxiety to recover them, became fearless of danger, and ventured into the repositories of foul vapours before the brattice was long enough to convey sufficient atmospheric air into them to render them wholesome. The 26th of July being Sunday, was a day of rest.

On the 27th of July seven bodies were obtained: 72 and 73 were much burnt, but not much mangled: 74, 75, 76, 77, were found buried amongst a confused wreck of broken brattices, trap-doors, trams, and corves, with their legs broken, or their bodies otherwise miserably scorched and lacerated. Before 78 was found the brattice represented in the last figure was taken down; a stopping put across the plane-board at number 41; and the air thrown past 79 and 54 through the aperture (which had been partly made by battering down the coal with a prop) and thence into the William Pit. This wall, on account of the prevalence of fire-damp, when 45 was found, had not been crossed till now.

The 28th of July was chiefly spent in putting up stoppings along the wall, from 78 to 79. Number 80 had been blown through a stopping.

Numbers 81 and 83, the latter under a fall, were found on the 29th of July.

On the 30th of July, the fall, which commenced a little east of 82, was found to continue, and 83 and 84 were dug from beneath it: 85 kept the sheth down-going door opposite the William Pit on the east; his hair, which was of a light colour, had been burned off; but had grown again to the length of an inch or more.

As all the upper parts of the mine in which there was a likelihood

of meeting with any bodies had been once carefully gone over, and it was known that three persons had not escaped from the newly formed boards on the south-east, the air, on the 31st of July, was diverted, and thrown up the head-ways from the plane-board. Number 86 perished by the first explosion; for as H. Anderson escaped he fell his body under his feet; but having a living boy in his arms he was unable to bring him out. He was employed in driving a waggon from the south crane at number 88. His horse, which was lying near him, had been turned round and thrown upon its back, by the force of the blast; its skin, when first visited, was as hard as leather, and, like the bodies of all the men, covered with a white mould: it was dragged whole to the shaft, and sent to bank in a net. After the atmospheric air acted a short time upon it, its skin and flesh soon lost their solidity, and became putrid.

August the 1st. The men, who had been working in the two boards north of number 87, made their escape up the wall in which he was found, to the crane-board, and thence down the head-ways. They called on him as they passed his board, but he made no answer. As he had been late up the night before, he is supposed to have been asleep when the accident happened. He was not at the place in which he was found when the men alluded to passed it: it therefore appears that he had made a struggle to escape after it was too late to be successful. A day or two before his death, he told some of his friends that he had a strong presage upon his mind that he had only a very short time to live: but who has not many times predicted his death before it arrived?

Number 88, discovered on the 3d of August, had the charge of a trap-door in the wall, in which 87 was found. Nature had left something deficient in his brain, which caused an employment to be assigned him in which little memory and contrivance were required. He was found close to the crane, under a very heavy fall.

All the trap-doors and stoppings in this part of the mine were standing when the workmen escaped. The lamp at the crane was still burning. They found no falls in their way out, nor saw any injury done by the first explosion. But when it came to be explored at this time, the stoppings and trap-doors were blown down, the roof fallen, and as great marks of destruction as in any other part of the mine. It is therefore probable that the atmospheric current passing each way, along the double head-ways, intercepted the pro-

gress of the first explosion, and prevented its igniting the fire-damp here. But the choak-damp, pressing up the head-ways to occupy the space of the atmospheric air, threw a train of fire-damp from hence into some part of the mine where the coal was burning, and this little magazine was blown up. Perhaps this may serve to explain the cause of the second explosion.

The workmen now began to be employed in carrying on a regular ventilation through the wastes of the mine by stoppings of brick.

On Thursday, the 6th of August, they found that the stable board had been on fire, and that the solid coal was reduced to a cinder, two feet in thickness. As far as the fire had extended, the roof was more fallen than in any other part of the mine. At this time it was ascertained that this fall occurred on the 14th of July. The fire here had probably been caused by the hay igniting at the explosion, and communicating to the coal. The air, too, while the pits were open, would have its strongest current up this board, and consequently keep the fire alive. This was the only place in which the solid coal had been on fire. In other parts the barrow-way dust was burnt to a cinder, and felt under the feet like frozen snow.

Number 89 was found under six or seven feet of stone. From this time the ventilation, and search for the remaining bodies, were uniformly persevered in, till September the 1st, when number 90 was discovered; he had been narrowly missed by some persons who visited this part in the dark, on the 18th of July.

The ventilation concluded on Saturday the 19th of September, when number 91 was dug from under a heap of stones. At six o'clock in the morning the pit was visited by candle-light, which had not been used in it for the space of 117 days; and at eleven o'clock in the morning the tube-furnace was lighted. From this time the colliery has been regularly at work; but the body of number 92 has never yet been found.

All these persons (except numbers 1, 4, 5, and 50, who were buried in single graves) were interred in Heworth Chapel-yard, in a trench, side by side, two coffin deep, with a partition of brick and lime between every four coffins. Those entered as "unknown" in the burial register have had names added to them since the search was discontinued.

[*Introductory Account prefixed to a Funeral Sermon preached on the occasion, by the Rev. John Hodgson.*]

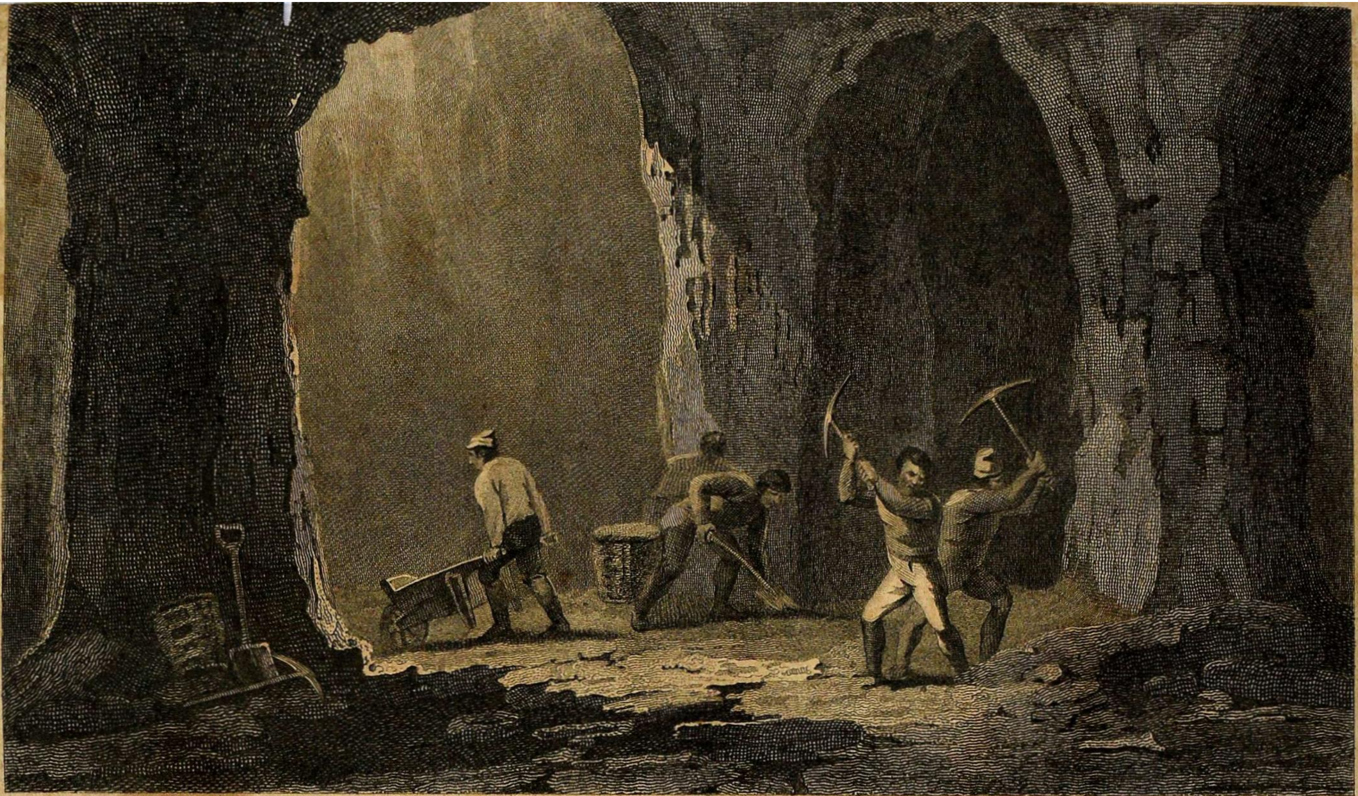
SECTION VIII.

SALT MINES.

1. *Introductory Remarks.*

CULINARY salt, or, in the language of modern chemistry, muriat of soda, exists abundantly in a native state, both in a solid form and dissolved in water, and it is very largely obtained from both these states for commercial use. Dissolved in water it occurs to us n various springs, rivers, lakes, and through the wide range of the ocean.

The cause of salt in the immense mass of waters that constitute the ocean is a very curious subject of enquiry upon which we shall touch in a subsequent chapter: our present attention is directed to it in a solid form and as a peculiar mineral; and under this form it is generally known to oryctologists by the name of *rock-salt, fossil-salt*, or *sal-gem.* Rock-salt is found in a cubic, fibrous, compact, and stalactitical shape. Its proper geological situation is between the oldest secondary gypsum and secondary sandstone. It forms continuous beds of great thickness, and often occurs in large solitary blocks; it is always accompanied by semi-indurated clay, for the most part strongly impregnated with salt; and alternates with beds of swine-stone, gypsum, limestone, and sand-stone. The beds of salt are mostly below the surface of the ground, but it sometimes rises into hills of considerable elevation. At Cordova, according to Bowles, there is a hill between four and five hundred feet high, composed entirely of this mineral. The most celebrated mines are those of Wielicza in Galicia, the Tyrol, Poland, Castile in Spain, and Cheshire in England. In the province of Lahor in Hindustan is a hill of rock-salt of equal magnitude with that near Cordova. The mines of Iletski in Russia, yield vast quantities of this substance. It is so plentiful in the desert of Caramania, and the air is so dry, that it is there used as a material for building; it forms the snrface of a large part of the northern desert of Libya, according to Horne-man; and is found abundantly in the mountains of Peru. It has a pure saline taste, without any mixture of bitterness; and crystallises in cubes when obtained by slow evaporation from its solution. In



Engraved by Ransom, from a Drawing by Clennell.

for the Gallery of Nature & Art.

SALT MINE AT CRACOW.

London, Published by R. Wilks, 89, Chancery Lane, March 1813.

Germany the mines of this kind are numerous: one of the largest is that at Hallein near Saltzburg, in which the salt is hewn out from subterranean caverns of considerable range, and exhibiting almost every diversity of colour, as yellow, red, blue, and white; in consequence of which it is dissolved in water to be liberated from its impurities, and afterwards re-crystallised.

2. *Salt Mines at Cracow.*

THESE celebrated excavations exist about five miles distant from the city of Cracow, in a small town called Wielicza. The town is entirely undermined, and the cavities extend far beyond it. The length of the mine from east to west is six thousand feet, its breadth from north to south is two thousand, and its greatest depth eight hundred; but the veins of salt are not limited to this extent, for the depth and length of them from east to west are yet unknown, and only the breadth has been hitherto determined. There are at present ten shafts, and within the whole salt-mine there is not so much as one spring. Here a stranger is surprised, on his descending to the bottom, to find a kind of subterraneous commonwealth, consisting of a great many families, that have their peculiar laws and polity; here are likewise public roads and carriages, horses being employed to draw the salt to the mouths of the mine, where it is taken up by engines. These horses when once they are down, never more see the light of the sun; and many of the people seem buried alive in this strange abyss, some being born there and never stirring out, though others have frequent opportunities of breathing the fresh air in the fields, and enjoying the light of the sun. The subterraneous passages or galleries are very spacious, and in many of them chapels are hewn out of the rock-salt; and in these are set up crucifixes, and the images of saints, before which a light is kept constantly burning. The places where the salt is hewn out, and the empty cavities whence it has been formerly taken, are called chambers. In some chambers, where the water has formerly stagnated, the bottoms and sides are covered with very thick incrustations of some thousands of salt-crystals, one upon another, many of them weighing half a pound or more; and when any candles happen to be brought, the nu-

merous rays of light reflected by these crystals emit a surprising lustre.

In some parts of the mine huge columns of salt are left standing, to support the rock. The number of miners employed are between four and five hundred, but the whole amount of men who work is about seven hundred.

In this subterranean town is a statue, which is considered by the immured inhabitants as the actual transmutation of Lot's wife into a pillar of salt; and as this statue appears either dry or moist, the state of the weather above ground is inferred. The windings in these mines are so numerous and intricate, that workmen have frequently lost their way, their lights having been burnt out, and have perished before they could be found.

The salt lies near the surface, in large shapeless masses, out of which blocks of sixty, eighty, or a hundred square feet may be hewn; but at a considerable depth it is found in smaller lumps. About six hundred thousand quintals of salt are annually dug out of these mines. The worst and cheapest is called green salt, from its greenish colour, caused by an heterogeneous mixture of a greyish mineral, or clay, and entirely consists of salt crystals of different dimensions. A cask of this salt, which generally contains six quintals, sells for about twenty-two Polish guilders, each of one shilling and two-pence value; but a quintal of that in large masses or blocks is worth thirty-two or thirty-three florins, each florin worth about sixpence halfpenny: the difference being from one pound four shillings to four guineas sterling the cask. A finer sort of salt is sold at a somewhat greater price, and frequently in large blocks. The third species of salt dug out of these mines is *sal gemmæ*, or crystal salt, which is found in small pieces interspersed in the rock, and when detached from it breaks into cubes of rectangular prisms. This is usually sold unprepared. The colour of the salt-stone is a dark grey mixed with yellow.

These salt-mines have always made a part of the king's board-revenues, as they were termed, and were generally farmed; but sometimes the king has kept them in his own hands, and appointed proper officers for the management of them. The office of mine-master at Wielicza was hereditary, and a considerable salary arising from them was annexed to it. In the year 1772 the empress queen seized upon these mines, and they have since remained annexed to

the dominions of the house of Austria; the King of Poland being put into possession of a territory which was rendered hereditary in his family in lieu of this revenue.

Dr. Darwin has alluded to this enormous mine, and the common theory of the formation of salt, with his usual spirit, in the following verses of his Botanic Garden.

> Gnomes! you then taught transuding dews to pass
> Through time-fall'n woods, and root-inwove morass,
> Age after age; and with filtration fine
> Dispart, from earths and sulphurs, the saline.
> Hence with diffusive Salt old Ocean steeps
> His emerald shallows, and his sapphire deeps.
> Oft in wide lakes, around their warmer brim
> In hollow pyramids the crystals swim;
> Or, fused by earth-born fires, in cubic blocks
> Shoot their white forms, and harden into rocks.
> Thus, cavern'd round, in Cracow's mighty mines,
> With crystal walls a gorgeous city shines;
> Scoop'd in the briny rock long streets extend
> Their hoary course, and glittering domes ascend;
> Down the bright steeps, emerging into day,
> Impetuous fountains burst their headlong way,
> O'er milk-white vales in ivory channels spread,
> And wondering seek their subterraneous bed.
> Form'd in pellucid salt, with chissel nice,
> The pale lamp glimmering through the sculptur'd ice,
> With wild reverted eyes fair Lotta stands,
> And spreads to heaven, in vain, her glassy hands;
> Cold dews condense upon her pearly breast,
> And the big tear rolls lucid down her vest.
> Far gleaming o'er the town transparent fanes
> Rear their white towers, and wave their golden vanes;
> Long lines of lustres pour their trembling rays,
> And the bright vault returns the mingled blaze.

3. *Rock-salt of Cheshire.*

In our own country the county of Cheshire is by far the most celebrated quarter for rock or mineral salt. The face of the soil, the springs that run through it, and the mode of working the salt are objects of high interest and entertainment; and have lately been so correctly and agreeably described by Henry Holland, Esq. in the

first volume of the Geological Transactions, that our readers will be obliged to us for the following summary.

The Cheshire rock-salt, with a few exceptions, has yet been ascertained to exist only in the valleys of the Weaver and its tributary streams; in some places manifesting its presence by springs impregnated with salt; in other places being known by mines actually carried down into the subtance of the strata. Between the source of the Weaver and Nantwich, many brine springs make their appearance; and in the latter part of this course, it would seem that brine might be obtained by sinking to some depth in any place near the banks of the Weaver. Proceeding down the stream, salt-springs occur again at Winsford, and in several situations between Winsford and Northwich. At Moulton, between these two places, a mine has been sunk into the body of rock-salt, and another also between Winsford and Middlewich. At Northwich the brine springs are very abundant, and here also many mines have been sunk for the purpose of working out the fossil salt. The springs occur again in several places further down the river, but none have been met with below Saltersford, about two miles from Northwich. At Whitley, however, two miles north of the Weaver, and six miles from Northwich, a body of rock-salt is stated to have been met with in boring for coal.

On the course of the river Wheelock, brine springs have been found at Lawton, Roughwood, Wheelock, and again at Middlewich, where this stream unites itself with the Dane. At Lawton, a mine has been sunk into the rock-salt. In the valley of the Dane no salt springs actually appear, but several circumstances indicate that brine has at some former period been discovered there, and this as high up the stream as the neighbourhood of Congleton. No springs have been found in the valley of Witton Brook, except at the part of it immediately adjoining the Weaver at Northwich.

The evidences of the presence of rock-salt occur in very few places out of these valleys, and even some of the excepted instances appear to have a local relation to the southern or central plain. This is the case with the salt springs of Dirtwich, in the south-western angle of Cheshire; with a spring of very weak brine lately found at Adderley, in the northern extremity of Shropshire; and probably also with other saline springs which occur in the contiguous parts of Flint and Denbighshire. At Dunham, however, in the

north of Cheshire, we find a weak spring, which cannot strictly be considered as connected with the formations of the southern plain. At Barton and Adlington, in the southern parts of Lancashire, brine springs likewise appear; and it is not improbable that other instances of the same kind may occur in the northern portion of the great plain. It appears possible, however, that these weak springs may derive their saline contents, not from distinct subjacent beds of the fossil salt, but merely from beds of clay or argillaceous stone, strongly impregnated with particles of the muriate of soda.

The brines met with in this district are very generally formed by the penetration of spring or rain waters to the upper surface of the rock-salt, in passing over which they acquire a degree of strength, modified by several circumstances, which it would be needless to detail. Their average strength, however, appears to be much greater than that of the springs met with in Hungary, Germany, or France. At Winsford, Northwich, Anderton, Lawton, Roughwood, Wheelock, and Middlewich, where all the principal salt works are situated, the brine springs contain between twenty-five and twenty-six per cent. of the pure muriat of soda; and in some of the springs at Anderton, the proportion stands as high as 26·566 per cent. a very near approach to the perfect saturation of the brine. The earthy salts held in solution together with the muriat of soda are principally muriat of magnesia and sulphat of lime; the quantity of these varying from $\frac{6}{10}$ per cent. to 2 or to $2\frac{1}{2}$ per cent. in different springs. The brine being pumped out of the pits, is first conveyed into large reservoirs, and afterwards drawn off as it is wanted, into evaporating pans made of wrought iron. Here heat is applied in a degree determined by the nature of the salt intended to be manufactured, and various additions are made to the brine, with a view either to assist the crystallization of the muriat of soda, or to promote the separation of the earthy salts. The latter exists in a very small proportion in the manufactured salt, and cannot be supposed in any degree to affect the uses to which it is applied. The importance of the Cheshire salt manufacture will be sufficiently obvious from the statement, that besides the salt made for home consumption, which annually amounts to more than 16,000 tons, the average of the quantity sent to Liverpool for exportation has not been less than 140,000 tons.

Though springs impregnated with salt occur in several parts of

the Cheshire plain, it may be remarked that the rock-salt itself has only been worked into, near the banks of the Weaver and its tributary streams. It was first discovered at Marbury near Northwich, about one hundred and forty years ago, in searching for coal. This bed of rock was the only one worked for more than a century, when, in the same neighbourhood, a second and inferior stratum was met with, separated by a bed of indurated clay from the one previously known. This lower stratum was ascertained to possess at a certain depth a great degree of purity and freedom from earthy admixture; on which account, and from the local advantages of Northwich for exportation, the fossil salt is now worked only in the vicinity of this place.

The rock-salt of Northwich occurs, in two great strata or beds, lying nearly horizontally, but on different levels, and separated, the superincumbent from the subjacent stratum, by several layers of indurated clay or argillaceous stone. These intervening beds possess in conjunction a very uniform thickness of ten or eleven yards, and are irregularly penetrated by veins of the fossil salt. Though the evidence on the subject is not entirely of a positive nature, there seem strong grounds for believing that the beds of rock-salt at Northwich are perfectly distinct from any others in the salt district, forming what the Germans would call *liegende stöcke*, lying bodies or masses of the mineral. It will readily be conceived that there is much difficulty in acquiring precise information with respect to the extent and limitation of these great masses, and that there are many sources of error to which such an inquiry is liable. There are, however, a few leading facts upon which dependence may be placed, and which will be admitted to furnish fair grounds for deduction.

It would appear that the great beds of rock-salt at Northwich assume a general longitudinal direction from north-east to south-west, the line which has been traced upon them in this direction being a mile and a half in length, and no direct evidence existing that they may not extend further in these points; while their transverse extent, as measured by a line at right angles to the former, is much more limited, probably not exceeding in any place one thousand three hundred or one thousand four hundred yards. Several circumstances concur in giving probability to this statement. Let two parallel lines, drawn from NE to SW, with an intervening distance equal to about half their length, be employed to designate

the supposed extent of the subjacent rock-salt. In a mine which approaches very nearly to the eastern limit of the area thus formed, the upper bed of rock-salt was actually worked through in an horizontal direction on this side, and discovered to be going off with a very rapid declivity. A similar fact has been stated with respect to another pit further to the south on the same line of boundary; but as the mine was destroyed many years ago by the ingress of fresh water, this statement is considerably more doubtful than the former. It may be remarked too, that in sinking for brine a little beyond, or out of the area, on this side, the brine met with is of a very weak and inferior kind, and at a short distance altogether disappears. Appearances leading to the same conclusion of the sudden termination of the body of rock-salt occur on the opposite side of the area marking its extent. In a mine at the northern extremity of the western line of boundary, a shaft situated nearer to this line is fifteen yards deeper than another shaft immediately contiguous, apparently in consequence of the rapid sinking of the rock-salt at this point. In most of the pits on this side, the upper bed of rock is met with at a depth of from thirty to forty yards; yet at Barnton, a mile further to the west, and on the same or a lower level, none was met with in a sinking of one hundred and fifteen yards.

Corresponding appearances have been observed in the body of rock-salt which occurs at Moulton, between Winsford and Northwich, where in two sinkings on the same level, and at the distance of one hundred yards from each other, the difference in the depth at which the rock was found was nearly twenty yards, a circumstance from which the limitation or going off of the bed at this particular point may reasonably be inferred.

Another important observation with respect to the Northwich rock-salt is, that there seems to be a progressive thinning of the upper bed of salt from NW to SE, or in a direction nearly at right angles to the longitudinal extent of the stratum. Though much uncertainty exists with respect to the rate and progression of this decrease, the general fact seems to be sufficiently confirmed by observations taken from different mines. In those which have been sunk near to the western or north-western side of the area before described, the thickness of the upper bed has been very generally twenty-eight, twenty-nine, or thirty yards. Proceeding towards the east or south-east, we find this thickness decreasing to twenty-five

yards, and in the mines near the eastern boundary the bed of rock-salt comes down to twenty, eighteen, and even seventeen yards in thickness. It will be observed that this thinning takes place in a general direction from the nearest sea-coast; the thickest part of the body of rock being situated furthest down the Weaver, and just above the contraction which takes place in the valley of the river at Anderton.

Besides this general variation of surface in the superior stratum of rock-salt, it has been found that there is a considerable irregularity of level on its upper surface. In one of the mines, in which a tunnel was carried one hundred yards along this surface, many small risings and depressions were met with; and similar appearances have been observed in the other mines near Northwich.

The depth at which the upper bed of rock-salt is found, though varied by several of these circumstances, depends principally, of course, upon the surface of the ground above, which at Northwich, from the confluence of streams there, is somewhat irregular. In the greater number of the mines, it is met with at a depth varying from thirty-five to forty yards. The smallest depth at which it has been found is in a mine situated close to Witton Brook, about half a mile above the entrance of this stream into the Weaver. Here it appears at twenty-nine yards from the surface; and a general estimate of level from this mine shows that the upper surface of the salt is at least twelve or thirteen yards below the low-water mark of the sea at Liverpool; a fact perhaps not wholly unimportant as regards our ideas of the formation of this mineral.

The thickness of the upper bed of salt at Northwich has been already stated to vary from twenty to thirty yards: that of the lower bed has never yet been ascertained in any one of the mines in this district. The workings in this lower stratum are usually begun at the depth of from twenty to twenty-five yards, and are carried down for five or six yards, through what forms, as will afterwards be mentioned, the purest portion of the bed. In one of the mines a shaft has been sunk to a level of fourteen yards still lower, without passing through the body of rock-salt. We have thus an ascertained thickness of this bed, of about forty yards, and no direct evidence that it may not extend to a considerably greater depth.

Though only two distinct beds of the fossil salt have been met with at Northwich, it has been ascertained that the same limitations

do not exist throughout the whole of the salt district. At Lawton, near the source of the river Wheelock, these distinct beds were found, separated by strata of indurated clay; one, at the depth of forty-two yards, four feet in thickness; a second, ten yards lower, and twelve feet thick; and a third, fifteen yards still further down, which was sunk into twenty-four yards, without passing through its substance. Coal is found and worked within two or three miles of this place, and the only limestone known in the county of Chester is got from the hills which here form the southern boundary of the plain. In no other parts of the salt district, than at Northwich and Lawton, has the upper bed of rock been worked through.

The strata passed through in going down to the upper bed of rock are nearly horizontal in position, and very uniform in their structure, consisting in every instance of beds of clay and marl; and these, with the exception of a few of the most superficial, appearing in similar progression in each mine. The clays, or argillaceous stone, of which these beds are composed, are indurated in different degrees, tinged with various shades of red, blue, brown, &c. and usually contain a portion of sulphat of lime. They are known to the miners by the general name of metals; a distinctive appellation being given to each from the shade of colour which it assumes. It will be observed that, though these clays in general possess a considerable degree of induration, there are some of them sufficiently porous to admit the passage of water through their substance. Where this structure of the clay occurs it goes by the name of the shaggy metal, and the fresh water which makes its way through the pores has the expressive appellation of Roaring Meg. This epithet will not appear too strong, when it is mentioned that in the mine from which the section of strata was taken, and where the shaggy metal was found at the depth of twenty six yards, the quantity of water, ascertained to issue from its pores in one minute, was not less than three hundred and sixty gallons; a circumstance greatly enhancing the difficulties of passing a shaft down to the body of rock-salt.

A portion of salt, sufficient strongly to affect the taste, is found to exist in many of these beds of argillaceous stone: and this saltness increases, as might be expected, as we approach the body of the rock-salt. In the strata or layers immediately above the rock, which in all the mines are perfectly uniform in their appearance and

structure, it is particularly remarkable. It may be observed, however, that there are not, in these strata any veins of rock-salt connected with the great mass below: on the contrary, the line of division between the clay and rock-salt is drawn with great distinctness in every instance, and presents none of those inequalities which would arise from a mutual penetration of the strata.

It may, perhaps, be considered as a decided fact, that no marine exuviæ or organic remains are found in the strata situated over the rock-salt; and the almost universal occurrence of gypsum, in connection with beds of fossil salt, is another fact worthy of observation. This connection appears in the salt mines of Hungary, Transylvania, and Poland, as well as in those of Cheshire, and it has led Werner to assign to the rock-salt and floetz gypsum a conjunct situation in his Geognostic System. The gypsum, contained in the clays over the Cheshire rock-salt, occurs in varying proportions, and under different appearances in the several beds passed through. It is found both in large masses and in small granular concretions. The compact, foliated, and fibrous varieties are all met with; the last of these occurring in very considerable proportion.

The fineness or purity of the rock is a circumstance very important to the interests of the mining proprietor, and in this point considerable varieties appear in different parts of the strata. The great body of the rock-salt, both in the upper and lower stratum, is composed of crystals of muriate of soda, intimately mixed with certain proportions of clay and oxyd of iron, giving to the mass a red or reddish-brown tinge: and, in addition to these constituent parts, contains likewise certain earthy salts, the sulphat of lime, and the muriats of lime and magnesia, but these in small proportion. In every part, however, of this compound rock, we find separate crystalline concretions of muriat of soda, variously disposed, sometimes occurring distinctly in the cubical form; in other places in masses of larger size, and irregularly shaped. The colour of these concretions, which are of the foliated species of fossil salt, is usually a greyish, or milk-white; they are always translucent, and often attain a considerable degree of transparency. It would appear that they contain the muriat of soda in its purest form; the sulphat of lime in specimens of this kind being scarcely distinguishable by the delicate tests applied to its discovery.

This finer rock-salt occurs not only in separate concretions, but also in veins intersecting the coarser mass, and in the rims or borders of the different polyhedral figures mentioned. Its proportion varies both in the two great beds of rock, and likewise in different parts of the same bed; and it is a regard to this circumstance which determines the situation and extent of the workings in the several mines. In the upper bed this variety is less considerable than in the lower; but here the substance of the rock-salt is evidently purer three or four yards above the lower surface than in other parts of the same stratum, and continues so for about four feet. In the lower bed, the first twenty or twenty-five yards passed through contain a proportion of earth as large as in the upper stratum: at this depth, however, a greatly increased degree of purity appears, which is continued for five or six yards further down, when the proportion of earthy admixture again becomes as large as before.

It is invariably this purer portion of the lower bed which is at present worked in the Northwich mines, and the rock-salt obtained from it, being principally exported to the Baltic, obtains the name of Prussian rock. The extent of the cavity formed by the workings varies in different mines; the average depth may probably be taken at about sixteen feet. In some of the pits, where pillars six or eight yards square form the supports of the mine, the appearance of the cavity is singularly striking, and the brilliancy of the effect is greatly increased if the mine be illuminated by candles fixed to the side of the rock. The scene so formed would almost appear to realize the magic palaces of the eastern poets. Some of the pits are worked in aisles or streets, but the choice here is wholly arbitrary. The methods employed in working out the rock-salt offer nothing worthy of notice. The operation of blasting is applied to the separation of large masses from the body of the rock, and these are afterwards broken down by the mechanical implements in common use. The present number of mines is eleven or twelve, from which there are raised, on an annual average, fifty or sixty thousand tons of rock-salt. The greater part of this quantity is exported to Ireland and the Baltic: the remainder is employed in the Cheshire district in the manufacture of white salt by solution and subsequent evaporation.

It is very doubtful whether in any instance the body of rock-salt

can be considered as stratified, or disposed in distinct layers. A perpendicular section does sometimes indeed present irregular appearances of this kind, and more especially in the purer part of the lower bed; but the great body of the rock offers to the eye merely a confused red mass, varied here and there by the occurrence of the crystalline portions of salt.

One of the most striking facts connected with the internal structure of the Northwich rock-salt, is the appearance observable on the surface of an horizontal section of the rock, as viewed in any of the mines. On this surface may be traced various figures, more or less distinctly marked, and differing considerably in the forms which they assume; some appearing nearly circular, others perfectly pentagonal, and others again having an irregular polyhedral form. The lines which form the boundary of these figures are composed of extremely pure white salt, forming a division between the coarse red rock exterior to the figure, and the equally coarse rock included within its area. These bordering lines or rims vary from two to six inches in width. The figures themselves differ greatly in size; some of them being less than a yard in diameter, others as much as three or four yards; and they very frequently are observed, one within another, gradually diminishing in size to a centre. Professor Playfair, in his Illustrations of the Huttonian Theory, has stated, that the compression of these figures is always mutual; the flat side of one being turned to the flat side of another, and never an angle to an angle, nor an angle to a side. This remark seems perfectly founded in fact. From the mode of working the mines, it is difficult to ascertain the progressive appearance of these figures in a perpendicular plane. It has been stated that their form is a pyramidal one, the area enlarging by a determinate ratio of increase as they are traced downwards; but several circumstances induce us to consider this statement as a very doubtful one, and certainly founded upon insufficient evidence.

One very important negative fact remains to be mentioned with respect to the internal structure of the Cheshire rock-salt, viz. that no organic impressions or remains have ever been met with in any of the beds of the mineral which have been worked in this district. This fact rests on evidence of a satisfactory kind, and there is not, perhaps, more than a single instance adduced in opposition to it, and that of a very dubious nature. The same remark may be ap-

plied to the strata of argillaceous stone between the two beds of rock-salt. The veins of rock-salt intersecting these intermediate strata contain principally the fibrous variety of the fossil. It may be remarked too of these strata, that at their junction with the upper and lower beds of rock-salt, the lines of division are nearly as distinct as that between the upper bed of rock and the superincumbent layers of argillaceous stone.

The general situation of the rock-salt in Transylvania and Poland is very similar to that which it occupies in Cheshire; the beds of this mineral being disposed in small plains, bounded by hills of inconsiderable height, forming a kind of basin or hollow, from which there is usually only a narrow egress for the waters. The situation of the Austrian salt-mines near Salzburg is however very different. The mineral here appears to be disposed in beds of great thickness, which occur near the summit of lime-stone hills, at a great elevation above the adjoining country. This fact is a singular one; and, if we admit the idea that rock-salt is formed from the waters of the sea, makes it necessary to suppose the occurrence on this spot of the most vast and wonderful changes. M. Hasenfratz states it as a general fact, that in countries where salt-mines occur, fragments of primitive rocks appear in great abundance over these beds. It does not seem, however, that any deduction of importance can be connected with this fact.

The disposition of the beds of salt in the continental mines seems to be very generally a horizontal one, and as in the English mines they are separated by strata of clay of a varying thickness. It would appear, however, with respect to extent of dimensions, that they are in general greatly inferior to the bodies of rock-salt met with in our own island. In Hungary and Poland these beds do not present a thickness of more than one or two feet, and are separated by layers of clay a few inches in thickness. Much, however, it is evident, must depend upon the number of the beds thus disposed; but this I do not find any where noticed. The earthy saline contents of the foreign rock-salt very exactly resemble those of the Cheshire; the gypsum existing in much larger proportion than the other earthy salts, and appearing in considerable masses, both distinctly, and in mixture with the beds of clay. It is an important fact, however, that sea-shells and other marine exuviæ are found in these beds of clay a gypsum; and circumstance which never occurs in the Cheshire

mines. It would seem that the portion of oxyd of iron combined with the clay in the substance of the English rock salt does not exist in the mineral as found abroad, or at least in a proportion not so considerable.

The comparative commercial value of the English and Polish mines is best ascertained by the fact, that many thousand tons of rock-salt are annually sent from Cheshire to the parts of the Prussian coast most nearly adjacent to the salt-mines; independently of the large supplies of the English manufactured white salt which are exported to the same country.

With respect to the theory of the formation of rock-salt, it must be acknowledged that though there are some difficulties connected with the supposition, little doubt can exist of the general fact, that the beds of this mineral have been formed by deposition from the waters of the sea. Such an opinion acquires much probability from the situation in which these beds usually occur; occupying the vallies and lower parts of plains which are so surrounded by hills of secondary formation, as to leave only a narrow egress for the waters collected on their surface. This structure of the plain constituting the salt district of Cheshire, regarded in its general character, leads strongly to the conclusion that the waters of the sea must, at some former period, have occupied the lower parts at least of the basin thus formed, which at that time had a level eighty or one hundred yards lower than the one now appearing, To account for the great depositions of salt in the lower parts of this basin, it is necessary to suppose that some barrier must have been afterwards interposed to prevent the free communication of the waters of the sea with those thus collected; and the general course of the streams, the position of the beds of rock-salt, and the contractions in the valley of the Weaver, which appear below Northwich at Anderton and Frodsham, point out with some distinctness the place where these obstructions may probably have occurred.

To explain the appearance of the strata of indurated clay, intermediate between the beds of salt, we must suppose that the obstruction still continued, when the deposition of salt from the waters first confined had nearly ceased; and that at this period the deposition of clay, which had hitherto been going on in conjunction with that of the salt, proceeded in a great measure alone; the salt which remained in the water being merely sufficient to form small veins in

its substance. When these strata had been deposited to a thickness of ten or eleven yards, it would appear that the barrier preventing the access of the sea to the basin or plain was again so far removed as to allow the entrance of a fresh body of sea-water; from the gradual evaporation of which, the formation of the upper bed of rock-salt took place; and there being then no further admission of sea-water to the plain, the superincumbent strata of clay and marl were successively deposited in the order in which they at present appear.

This is a general sketch of the probable mode of formation of the Cheshire rock-salt; but as it would seem very doubtful whether any single accumulation of sea water could contain the materials of depositions possessing so great a thickness, the theory might perhaps be successfully modified, by supposing the barrier before noticed to have had such an elevation in the progressive stages of the deposition of the salt, as to allow the very frequent ingress of sea water into the basin. Admitting this idea, we must suppose that the formation of the strata of indurated clay between the beds of rock-salt took place, either during some intermission of these overflowings, or when there was a great predominance of this earth in the water from which the depositions were made. It seems probable too that the veins of salt intersecting these strata were formed rather by the penetration of water holding salt in solution, from the upper bed of rock-salt, than by a direct deposition from the waters of the sea. With respect to the sources of the clay, combined with the substance of the rock-salt, or found in intermediate and superincumbent beds, little doubt can exist that it has been derived from the decomposition of more ancient rocks, of the situation and precise characters of which no vestiges now remain.

This general idea of the formation of the Cheshire rock-salt derives confirmation from the fact that, with the exception of the sulphat of magnesia, the same earthy salts occur together with the muriat of soda in these strata, as are met with in the waters of the sea. The circumstance of the beds decreasing in thickness as they recede from the sea, may perhaps be admitted as another argument in behalf of the opinion.

The principal objection to the theory undoubtedly is, the non-existence of marine exuviæ either in the rock-salt or in the adjacent strata of clay; a fact very difficult to connect with the idea of a deposition from the waters of the sea. Other objections, though

perhaps of less moment, arise from the appearance of the earthy salts in smaller proportion in the rock-salt than in sea water; from the apparently partial deposition of the beds, and from the difficulty of explaining the formation of the figured appearances which occur in the substance of the rock. These circumstances, however, will by no means authorize us to reject the general idea which has been given of the origin of this mineral, strengthened as it is by the situation and appearances observed in the foreign salt mines, where the proofs of marine deposition are still stronger than those presented in the Cheshire district.

Section of the Strata sunk through to the second Bed of Rock-Salt, at Witton, near Northwich.

No.	Nature of the Strata.	Yards.	feet.	inch.
1	Calcareous marl	5	—	—
2	Indurated red clay	1	1	6
3	Indurated blue clay with sand	2	1	—
4	Argillaceous marl	1	2	—
5	Indurated blue clay	—	1	—
6	Red clay, with sulphat of lime irregularly intersecting it	1	1	—
7	Indurated blue and brown clay, with grains of sulphat of lime interspersed	1	1	—
8	Indurated brown clay, with sulphat of lime crystallized in irregular masses, and in large proportion	4	—	—
9	Indurated blue clay, laminated with sulphat of lime	1	1	6
10	Argillaceous marl	1	1	—
11	Indurated brown clay, laminated with sulphat of lime	1	—	—
12	Indurated blue clay, with laminæ of sulphat of lime	1	—	—
13	Indurated red and blue clay	4	—	—
14	Indurated brown clay, with sand and sulphat of lime irregularly interspersed through it. The fresh water (360 gallons per minute) finds its way through holes in this stratum, and has its level at sixteen yards from the surface	4	1	—
15	Argillaceous marl	1	2	—
16	Indurated blue clay with sand, and grains of sulphat of lime	1	—	9
17	Indurated brown clay, with a little sulphat of lime	5	—	—
18	Indurated blue clay, with grains of sulphat of lime	—	1	6
19	Indurated brown clay, with sulphat of lime . .	2	1	—
20	The first bed of rock-salt	25	—	—
21	Layers of indurated clay, with veins of rock-salt running through them	10	1	6
		76	2	9
22	The second bed of rock-salt, which has been sunk into 35 or 36 yards.			

[*Phil. Trans. Geolog. Trans. Pantolog. Darwin.*]

SECTION IX.

Marbles, Spars, Flints, Asbestus, and Gems.

In the language of the statuary and architect, all stones come un-under the name of marble that are harder than gypsum, occur in considerable masses, and are capable of a good polish.

Hence not only many varieties of limestone, but also granite, porphyry, serpentine, and even the fine-grained basalts, are called marble. Among mineralogists, however, the term is used in a more restricted sense, being confined to those varieties of dolomite, swinestone, and compact and granularly foliated limestone that are capable of receiving a considerable polish. Of these calcareous marbles the most valuable for hardness, durability, and colour, are procured from Italy, from the Greek islands, and from Syria: the ancient Romans, when at their height of civilized luxury, also obtained from Numidia and other districts in Africa some highly-esteemed varieties of marble.

The white granularly foliated limestone has always been the favourite material of the sculptors of ancient Greece and modern Europe, both on account of its pure colour, its delicate translucence, and its granular texture, which renders it much more easy to work than compact limestone. Dolomite possesses similar advantages, and is somewhat softer and of a finer grain: several of the smaller works of the Greek sculptors are of this material. The two great sources whence the statuary marble of Europe has been procured are Paros and Carrara. The Parian marble is the purest, consisting of hardly any thing else than carbonat of lime; hence it is softer, somewhat more transparent, and of a more visibly laminated texture than that of Carrara, which is mingled, often in considerable proportion, with granular quartz.

The most esteemed of the architectural marbles are the following.

1. A deep blue-coloured marble, called bardiglio, from Carrara, which appears to differ only in colour from the white statuary marble of the same place.

2. Cipolin marble, which is statuary marble traversed by veins of mica.

3. Lumachelle marble, which is a secondary compact limestone of a grey, or greyish-brown colour, holding shells that still re-

tain their pearly lustre. The fine marble of Bleyberg, in Carinthia, is the most valuable of this variety; the base is a greyish-brown compact limestone, in which are implanted shells of a fire colour and beautiful iridescent lustre.

4. Florentine marble, which is a compact very argillaceous limestone, of a grey colour, with designs of a yellowish-brown representing architectural ruins.

5. The yellow marbles of Syria, Sienna, and Arragon.

6. The green marbles known by the names of campan, verde antiche, verde di Corsica, &c. which are mixtures of granularly foliated limestone, calcareous spar, and serpentine, with threads of asbestos.

7. A very rich breccia, called brocatelli, containing small fragments of yellow-red and purple limestone, cemented by semitransparent white calcareous spar.

Of the marbles that the British islands produce, that of Tiree deserves the first place; and if its colours were not apt to fade, it might rank amongst the most beautiful even of Italy. The counties of Devonshire and Derbyshire also afford several varieties of considerable beauty, though by no means to be compared with the most esteemed of Italy and Spain.

There is a very singular species of marble found in Mount Gothard in Swisserland, and perhaps in a few other places, which is elastic, and capable of being bent without breaking. The Abbé Fortis has given a curious account of five or six tables of this elastic marble in the possession of the Prince of Borghese. Being set on end, they bend backward and forward; when laid horizontally, and raised at one end, they form a curve; if placed on a table, and a piece of wood, or any other substance, be laid under them, they fall into a kind of curve, each end touching the table. Notwithstanding this flexibility, they are liable to be broken if indiscreetly handled. The length of each is about two feet and a half: they are about ten inches broad, and three thick. They were dug up, as the abbé was told, in the signiory of Mondragone. The grain is of Carranese marble, or perhaps of the finest Greek; they seem to have suffered some attack of fire: they are perhaps susceptible of a polish. Our author adds, that they surprise all the naturalists who have seen them, who declare their nature to be quite inexplicable.

The elastic marble is phosphoric; and there are several other

species that are still more so; or, in other words, that emit an irridescent light under particular circumstances, some of them on being merely rubbed in the dark, and others on being previously exposed to a strong heat.

2. Of these kinds of phosphorescent stones, however, the most curious is that which is generally recognised by the name of the Bolognian or Bononian stone. It is in fact a subspecies, according to the classification of Werner, of heavy spar, or native sulphat of barytes. A casual discovery by Vincenzio Cascariolo, a shoemaker of Bologna, about 1630, was the first circumstance that attracted the notice of philosophers to this curious subject. This man being in quest of some alchemical secret was induced to calcine a parcel of Bolognian spar, which he had procured from Monte Paterno in the neighbourhood of the city; and observed that whenever this substance thus prepared was placed in a dark room, after having been exposed to the sun, it continued to emit faint rays of light for some hours afterwards. In consequence of this interesting discovery the Bolognian spar came into considerable demand among natural philosophers, and the curious in general, so that the best method of preparing it became an object of even some pecuniary importance. The family of Zagoni were the most successful in this pursuit, and in consequence furnished large quantities of Bolognian phosphorus to all parts of Europe, till the subsequent discovery of more powerful phosphori put an end to their monopoly. The particular process employed by the Zagonis is not known; but we learn from Kircher, that if the mineral is finely pulverized and then beaten up into a paste with white of egg or linseed oil, and calcined in the open fire, it will after exposure for a minute to the light exhibit its phosphorescent quality. Many years afterwards Marggraaf, in analysing other varieties of sulphated barytes, found that they were all capable of being made into phosphori by forming them, when pulverized, into thin cakes with gum tragacanth or other mucilage, and then carefully calcining them at a red heat. Some management however is requisite in conducting the calcination that it may be neither too much nor too little, by either of which faults the luminous quality is very materially injured.

In the year 1677, or nearly half a century after the discovery of the Bolognian phosphorus, G. A. Baldwin, a native of Misnia, observed that if nitrat of lime was evaporated to dryness, and then

formed into a compact mass by fusion at a red heat, it would exhibit the same property of imbibing and emitting light as the former, only somewhat inferior in degree; hence this preparation obtained the name of Baldwin's phosphorus.

3. It is a singular fact, that no lime-stone of any kind has hitherto been discovered in that vast tract of the habitable world which has been latest discovered, and which is generally known by the name of New Holland, the australasia of the French geographers; in consequence of which the builders are obliged to employ coral or the shells of shell-worms, for their mortar: which last are collected in prodigious abundance all along the coasts for this purpose. It is perhaps equally singular, that the silicious fragments commonly called flints are rarely to be met with in Norway; and, according to Pennant, seldom or ever to be found in that county of North Wales, which, from the name of *Flint-shire*, would pre-induce us to expect them in peculiar abundance.

PEBBLES differ chiefly from flints in their being enriched and variegated with colouring materials. The most singular pebbles of which we have hitherto had any account are the *sonorous stones* of China; concerning which we shall present the reader with the following curious description from the Abbé Grosier.

Among the musical instruments of China, the oldest and most esteemed is composed of a kind of stone which has the property of being sonorous. It would be difficult to determine whether the first colony that inhabited China carried thither the idea of a musical instrument made of stone, or whether the sonorous stones that are found there led to this happy invention. An old commentator of the Chou-king says, the ancients having remarked that a current of water made some of the stones near its banks send forth a sound, they detached some of them, and, being charmed with the delightful sound they emitted, constructed *king* or musical instruments of them.

The various kinds of sonorous stones known in China differ considerably from one another in beauty and in the strength and duration of their tone, and, what is very surprising, this difference cannot be discovered either by the different degrees of their [illegible]ness, weight, or fineness of grain, or by any other qualities which might be supposed to determine it. Some stones are found remark-

ably hard, which are very sonorous; and others, exceedingly soft, which have an excellent tone; some, extremely heavy, emit a very sweet sound; and there are others, as light as pumice-stone, which have also an agreeable sound.

The stone called *yu* is the most celebrated, valuable and beautiful of the sonorous stones known in China. It appears to have existed there from the remotest antiquity. If we believe what the ancient Chinese authors relate of the stones called *yu* of their time, if they have not exaggerated their beauty and perfections, we cannot help acknowledging that those found at present are far inferior; but what seems to assures us of the si cerity of these ancient writers, is, that this stone, which appears to have been known under the first *Tcheou*, whose dynasty began in the year 1122 before Christ, was very rare under the dynasty of *Han*, which commenced 206 years before our æra. At that period, these stones were the most valuable presents that could be made to the emperors. *Tching-ty*, of that dynasty, who mounted the throne thirty-seven years before Christ, considered it as a glorious epocha of his reign, when an ancient *king*, composed of sixteen stones, all of *yu*, had been found on the banks of a river.

These sonorous stones are found at present in channels made by torrents, and in the rivers which flow at the bottoms of the mountains of *Yun-nan*, *Koei-tcheou*, *Chen-si*, *Y-ly*, and *Yoquen*. The stone *yu* resembles externally those pebbles which are found in the streams and torrents that rush down through the clefts of the mountains. The large *yu* are very rare; the biggest that the missionaries ever saw in the imperial palace were only two feet and a half or three feet in length, and one foot eight or ten inches in breadth; and these were considered as matchless pieces. The *yu* are also found in the earth, in vallies near mines, and in the fissures made by torrents in the sides of the mountains. These differ from others, because their surface is not so smooth, and because they are neither of so firm a texture, nor of so fine a grain.

Five different properties are remarked in the sonorous *yu*; hardness, weight, colour, grain, and sound.

Beautiful *yu* are so hard when cut and polished like agate and precious stones, that the best-tempered steel glides upon them without making any impression. The more careful nature has been in

forming them, the more difficult it is to cut them; but they are capable of receiving a superior polish.

The weight of the *yu* is proportionable to its hardness. An unpolished block is preserved in the emperor's palace, which to all appearance one man could lift; but four are necessary only to move it: this piece, however, is no more than two feet and a half in length, and half a foot in breadth. It is of an irregular figure, and has a green colour, which is generally that of the commonest kind of *yu*.

The colour most esteemed at present in these stones, and which is indeed the prettiest, is that of whey; those that are next, are bright blue, azure, indigo, citron yellow, logwood red, pale green, sea green, deep green, cinder grey, &c. The Chinese set more value upon *yu* which is of one colour only, without veins or shades, unless it be variegated in an agreeable manner with five colours.

With regard to the grain of the *yu*, the hardest and heaviest has always the finest. But what kind of *yu* is the most sonorous? The missionary who transmitted us these details confesses that he cannot answer this question, because he never found an opportunity of making the necessary experiments: the emperor alone is in possession of all the various kinds which would be requisite for this purpose; it is, beside, doubtful whether there are different *king* made of the same size and dimensions, without which they could not be properly compared.

The *nieou-yeou-che*, or *ox-fat-stone*, is the second kind of sonorous stone known in China. It has neither the hardness, weight, nor sweet tone of the *yu*, and is more common, and much less esteemed: however, it is very rare to find large pieces of it proper for making *king*. That which is in greatest request has really the colour of the fat of beef, and is of one shade, without clouds or veins. This stone is a production of the province of *Yun-nan*, and is found in the earth near mines, in valleys, or at the bottoms of the mountains. Its exterior coat is rough, and of a dirty colour, between chesnut and green; below this there is a second, resembling curdled milk; after which comes another, tinged with yellow, that becomes deeper as it approaches the centre. It might be worth while to examine why the centre of this stone is better formed, more compact, and of a finer texture, and deeper colour, than its other parts. The *yu* emits sparks when struck with steel: the *nieou-yeou-che*

does not. This stone seems more to resemble agate; and perhaps may be an agate peculiar to China. To be sonorous, the *nieou-yeou-che* must have a beautiful yellow colour, without transparent veins; but it is far from being so sonorous as the *yu*.

The third kind of sonorous stone, named *hiang-che*, emits so metallic a sound, that one would be almost induced to take it for a composition; but it is certain that it is of the nature of stone. Some of them are found black, grey, green, and others variegated with white. The blackest are the most sonorous. This singular stone is brought from the lake of *Tche-kiang*, and appears to be a kind of alabaster, the colour and nature of which have been changed by the water that has penetrated it.

A fourth kind of sonorous stone resembles marble in its veins, which are grey, black, and dirty white, on a milk-white ground. The greatest part of these stones have transparent spots, which shew that a vitrification has commenced. They appear to be something between talc and crystal. It is remarked that their tone is often interrupted, and of very short duration.

The chemists and naturalists of Europe have never yet attempted to discover whether some of our stones may not have the same properties as the sonorous stones of the extremities of Asia. It however appears, that the Romans were formerly acquainted with a sonorous stone of the class of *hiang-che*. "Pliny," says the Abbé du Bos, "in his Reflections on Poetry and Painting, when speaking of curious stones, observes, that the stone called *calcophonas*, or *brazen-sound*, is black; and that, according to the etymology of its name, it sends forth a sound much resembling that of brass when it is struck. The passage of Pliny is as follows: *Calcophonas nigra est; sed illisa, æris tinnitum reddit.*" Lib. xxxvii. sect. 56.

Some sonorous stones sent into France have at length roused the curiosity of the chemists; and they have thought proper to inquire to what class of stones they may belong. The late Duke de Chaulnes applied with particular attention to this research. The following is the result of the experiments which he made on a *king* in the cabinet of Mr. Bertin.

In the Academy of Sciences, Mr. Romé de Lisle, and several other learned mineralogists, when asked if they were acquainted with

the black stone of which the Chinese *king* were made, for answer, cited the passage of Pliny mentioned by Boethius, de Bott, Linnæus, and in the Dictionary of Bomare, and added, what Mr. Anderson says in his Natural History of Iceland, respecting a blueish kind of stone which is very sonorous. As the black stone of the Chinese becomes of a blueish colour when filed, it is probably of the same species. None of the rest who were consulted had ever seen it.

The Chinese stone has a great resemblance at first sight to black marble, and, like it, is calcareous; but marble generally is not so norous. It also externally resembles touchstone, which is a kind of basaltes, and the basaltes found near volcanoes; but these two stones are vitrifications.

Its resemblance to black marble induced me to make some comparative experiments. It is not phosphoric; neither is black marble. It has no effect upon a suspended iron bar; and consequently contains no iron in its metallic state. When dissolved in acids, to try whether it contained any particles of that metal, it produced a strong effervescence, which seemed to indicate that it was not entirely free from them. As black marble did not present the same phænomenon, the sonorous stone was examined more attentively by a magnifying glass, when several small points, resembling pyrites, were discovered in it, to which this difference was attributed. When dissolved in nitrous, marine, or vitriolic acids, it always presented the same phænomena as black marble; with vitriolic acid it makes a greyish *magma* (which is only a kind of calx tinctured with bitumen), and leaves behind it a black substance that is not soluble in nitrous or marine acids, and which, as in black marble, is a real inflammable bitumen.

Black marble and sonorous stone, when calcined, become entirely white, and yield a very strong calx; but it loses its bitumen by the action of fire. Sonorous stone, however, appears to contain less of the phlogistic and colouring matter; for, a precipitation of it, by means of fixed alkali, is somewhat whiter (and has even more of a blueish cast) than that of black marble. When tried by volatile alkali, it contains no copper. Other precipitations of it, by different substances, exhibit the same appearances.

The Duke having proceeded thus far in his analysis, endeavoured to procure some further information from the stone-cutters They all replied, that blue-coloured marble was very sonorous, and

that they had seen large blocks of it which emitted a very strong sound; but the Duke having ordered a *king* to be constructed of this kind of stone, it was found that it did not possess that property. By trying the black marble of Flanders, a piece was at length found which emitted an agreeable sound: it was cut into a *king*, that is almost as sonorous as those of China. All these observations give us reason to believe that the stones of which the *king* are formed, are nothing else but a black kind of marble, the constituent parts of which are the same as those of the marble of Europe, but that some difference in their organization renders them more or less sonorous.

The Duke farther observes, that the Chinese make *king* of crystal, and that one of this kind is to be seen at St. Brice, in the cabinet of M. de la Tour, secretary to the King: that they also employ a kind of alabaster, some pieces of which M. Bertin received from China shaped like the *king*, made of black stone, that were said to be very sonorous; but they do not appear to have any sound at all; lastly, that the stone *yu*, of which the Chinese construct their most beautiful *king*, is nothing else but a kind of agate.

4. Closely connected with the part of the mineral kingdom immediately before us, and well worthy of observation from its peculiar qualities, is the *Asbest*, or *Asbestus*, and especially that variety of it which is called Amianth or Mountain Flax. The Asbest is, in all its varieties, more or less flexible, but considerably so in those forms of it which are known by the name of *Mountain Cork*, *Mountain Leather*, and Elastic Asbest, found of various colours in the mines of Sweden, Saxony and Hungary: and more especially, as just observed in the Amianth or Mountain Flax.

The usual colour of Mountain Flax is greenish white, passing into leek-green; or silver-white, yellowish-white, ochre-yellow, pale flesh red, and, very rarely, light blue. It is found sometimes in small separate bundles, but more usually in irregular fibrous masses. Its lustre is glimmering or slightly shining, and is either weak, pearly or silky. It is easily divisible into long slender flexible fibres, may be scratched by the nail, and has a soft somewhat greasy feel. It is generally opaque, but sometimes is translucid on the edges. Its specific gravity is subject to great variety; that of the most flexible and perfectly fibrous is only 0.908; that of the most compact is 2.313.

According to a late analysis of this mineral by Chenevix it appears to contain

25.	magnesia,
59	silex,
3.	alumine,
9.25	lime,
2.25	oxyd of iron.
91.5	
1.5	loss
100.	

Before the blowpipe amianthus melts with some difficulty into an opaque globule, which becomes dark-coloured by the continued action of the flame. If exposed to a high heat in an earthen crucible, it melts into a dense slag, strongly adhering to the vessel, of a yellowish grey colour: the surface of this slag is overspread with crystalline needles, crossing each other in all directions, or radiating from a common centre. If the heat is considerably increased, the whole melts into a green glass, and in a short time passes through the crucible. A specimen of amianthus from Greenland, being inclosed by Klaproth * in a charcoal crucible, and exposed to the full heat of a porcelain furnace, fused into a finely porous mass, of a dirty pearl-grey colour, covered externally with grains of iron.

This mineral is met with in potstone or serpentine rocks, either dispersed through them or accumulated in their clefts and crevices, unmixed with any other substance. The most beautiful comes from the Tarentaise in Savoy; it is in white-flexible filaments, sometimes a foot long, of a pure silky lustre. In some parts of Corsica it is so common as to have been used by Dolomieu instead of hay or moss, to pack up specimens of other minerals in. The islands of Elba and Crete; Zoblitz, in Saxony; Suartwick, in Sweden; Cornwall and Anglesey, in England; and Portsoy, in Scotland, also furnish considerable quantities. A compact kind, which decomposes by exposure to the air into remarkable flexible threads, is found in the Oural Mountains in Siberia.

The fibrous texture of amianthus, its incombustibility, and the little alteration that it undergoes even in a strong heat, were early

* Analyt. Ess. vol. 1.

noticed, especially among the Eastern nations; and methods were found out of drawing the fibres into thread, and afterwards weaving it into cloth. This, when dirtied with grease, or other inflammable matter, was cleaned by throwing into a bright fire; the stains were burnt out, and the cloth was then removed, but little altered in its properties, and of a dazzling white, hence it obtained from the Greeks the name *αμιαντος*, or *undefiled.* In the rich and luxurious times of the Roman empire, this incombustible cloth was purchased at an enormous price, for the purpose of wrapping up the bodies of the dead previously to their being laid on the funeral pile. The practice of burning the dead falling into disuse, occasioned the manufacture of amianthine cloth to be neglected, and at length entirely forgotten in Europe; but though it has ceased to be an article of necessity or luxury, yet the method of its preparation has occasionally attracted the notice of travellers and occupied the time of the curious. Ciampini,* of Rome, in 1691, published the following as the best way of preparing the incombustible cloth. Having previously steeped the amianthus in warm water, divide its fibres by gently rubbing them with the fingers, so as to loosen and separate all the extraneous matter; then pour on repeatedly very hot water, as long as it continues to be in the least discoloured. Nothing will be now left but the long fibres, which are to be carefully dried in the sun. The bundles of thread are to be carded with very fine cards, and the long filaments thus obtained are to be steeped in oil, to render them more flexible. A small quantity of cotton or wool is to be mixed, and by means of a thin spindle the whole is to be drawn out into thread, taking care that in every part the amianthus may be the principal material. The cloth being then woven in the usual manner, is to be placed in a clear charcoal fire to burn off the cotton and oil, when the whole remaining tissue will be pure white amianthus. The shorter fibres that are incapable of being woven, have been sometimes made into paper, the process for which is the same as that employed for common paper, except that a greater proportion of paste or size is required: after having been made red hot, however, this paper becomes bibulous and brittle. Amianthus threads are also sometimes used as perpetual wicks for lamps; they

* De incombustibili lino.

require, however, to be cleaned occasionally from the soot that collects about them, and the fibres in the hottest part of the flame are apt to run together, so as to prevent the due supply of oil. In Corsica,* amianthus is advantageously employed in the manufacture of pottery: being reduced to fine filaments, it is kneaded up with the clay, and the vessels which are made of this mixture are lighter, less brittle, and more capable of bearing sudden alterations of heat and cold than common pottery. [*Editor.*

CHAP. XXIX.

SUPERFICIAL PHÆNOMENA OF THE EARTH.

IN the opening chapter of the present book we remarked, that we should divide the subject of which it treats, and which we denominated GEOLOGY in the most extensive sense of the term, into three parts, the *subterranean*, the *superficial*, and the *atmospherical* phænomena, which the general mass of the earth presents to us, so far as we have been able to examine into them.

We have now cursorily run through the first of these divisions, as to those points, we mean (for our plan extends no farther), which are most curious or worthy of attention. And we shall next proceed to sketch, with a rapid hand, the more extraordinary lineaments that characterize the external appearance of the globe, and immediately constitute its superficies. In doing this, however, we must remark, and the observation will apply to every part of nature, organized as well as unorganized, inanimate as well as animated, that one division presses in many instances so closely upon the footsteps of another, and appears so intimately connected with it, that it is often a task of no common difficulty to say to which particular division an individual species or phænomenon may best appertain. Thus volcanoes constitute in many cases, a part both of the superficial and the subterranean departments of the globe; they form both profound cavities, and elevated mountains; but as their origin and power seem chiefly connected with the former, we have treated of

* Haüy Mineralog. vol. iii. p. 252.

them under that division. Mineral springs have, in various cases, a like relation, to both these divisions, but as being in their general composition and nature, more immediately related to the vast mass of waters which constitutes the ocean, and comprizes by far the largest extent of the earth's surface, we have not thought it consistent to separate them from that division to which the ocean obviously appertains, and shall hence treat of them in a subsequent chapter in their regular order.

The division, therefore. to which this chapter may be regarded as introductory, will comprize a brief survey of such Mountains and precipices as yet remain to be considered, the most singular cataracts and rivers which issue from them, whirlpools, springs, baths, vapours, lakes, seas, coral islands, currents, and tides.

CHAP. XXX.

MOUNTAINS, HILLS, PRECIPICES, PROMONTORIES, BASALTIC COLUMNS, AND DESERTS.

SECTION I.

Introductory Remarks.

WHOEVER has attentively surveyed the earth's surface, and studied nature on a grand scale, has been constantly struck with admiration and astonisment at the sight of such majestic eminences, which, extending in different ways, seem to rule over the rest of the globe, and which present to the beholder a spectacle equally magnificent and interesting. In them it has been supposed we must search for a solution of the important problem regarding the creation of the world.

Naturalists reckon several kinds of mountains; and conjecture that these elevations of the earth have not all the same origin, nor date their commencement from the same era.

1. Those mountains which form a chain, and which are covered with snow, are considered as primitive or antediluvian. They are like majestic bulwarks scattered on the surface of the globe, and

greatly exceed the other mountains in height. In general, their elevation is very sudden, and their ascent very steep and difficult. Their shape is that of a pyramid crowned with sharp and prominent rocks, on which no verdure is to be seen, but which are dry, naked, and as it were stripped of their soil, which has been washed away by the rains, and which present an awful and horrible aspect, sufficient to impress the coldest imagination with terror. These primitive mountains, which astonish the eye, and where the winds only reign, are condemned by nature to perpetual sterility. At the foot of them we frequently find paths less steep and winding than when we ascend to a greater height. They every where present thundering cascades, frightful precipices, and deep valleys. The depressions and excavations correspond with the quantity of water, the motion of which is accelerated in its fall, and which sometimes produces a total sinking or an inclination of the mountain. The wrecks to be found at the foot of most peaks show how much they have suffered from the hand of time. Nothing meets the eye but enormous rocks, heaped in confusion on one another, which prevent the approach of the human race. On the summit of these mountains or high eminences, which are only a series of peaks frequently detached from one another, the prominent rocks are covered with eternal snow and ice, and surrounded with floating clouds which are dissipated into dew. In a word, the rugged cliffs oppose an inaccessible rampart to the intrepidity of man: and nature exhibits a picture of disorder and decay. No shells or other organized marine bodies are to be found in the internal part of these primitive mountains: and though search has been made, by digging, on the tops of the Alps and Pyrenees, no substances of this nature have yet been discovered, except on the sides near the base. Nothing is to be met with but continued rocks, caverns dug by the hand of nature, and abounding in crystallizations of great beauty, with various minerals. The stone of which they consist is an immense mass of quartz, somewhat varied, which penetrates into the bowels of the earth in a direction almost perpendicular to the horizon. We find no calcareous spar but in the fissures or rents which have some extent and an evident direction; and at great depths we find new parts as it were, or, in other words, the primitive state of things. All primitive mountains furnish proofs of these assertions. Of this kind in Europe are the Pyrenees, the Alps, the Apennines, the mountains of Tyrol, the

mountain of the giants in Silesia, the Carpathian mountains, the mountains of Saxony, those of Norway, &c. In Asia we find the Riphean mountains, Mount Caucasus, Mount Taurus, and Mount Libanus: in Africa, the mountains of the Moon; and in America, the Apalachian mountains, and the Andes or Cordilleras. Many of the latter have been the seats of volcanoes.

2. Another kind of mountains are those which are either detached, or surrounded with groups of little hills, the soil of which is heaped up in disorder, and the crust gravelly, and confusedly arranged together. These are truncated, or have a wide mouth in the shape of a funnel towards the summit, and which are composed of, or surrounded with, heaps of calcined and half-vitrified bodies, lava, &c. This class of mountains appear to have been formed by different strata raised up and discharged into the air, upon occasion of the eruption of some subterraneous fire. The isles of Santorin, Monte-Nuovo, Mount Etna, Adam's Peak in the island of Ceylon, the Peak of Teneriffe in the Canary Islands, and many others, have been formed in this manner. When very high mountains of this kind are covered with sea-shells, we may consider their summits as having once constituted a part of the bottom of the ocean. A number of these mountains have been formed in the memory of man; and present nothing to the view but disordered ruins, confused masses, parts heaped together in the greatest irregularity, and productions formed by eruptions or by the falling in of the earth. When a mountain of this kind is connected with the land, and advances farther into the sea than the adjoining country, it is then termed a Cape, Head, or Promontory; such as the Cape of Good Hope at the southern extremity of Africa. Mountains of the second rank are commonly more easy of access. Dr. Haller observes, that the angle formed between their base and their declivity is larger; that they have fewer springs; and that their plants are different from those of the Alps. The peasants in Swisserland, he tells us, are acquainted with the difference betwixt these two kinds of mountains.

3. Those mountains, whether arranged in a group or not, the earth or stone of which is disposed in strata more or less regular, and consisting of one or more colours and substances, are supposed to be produced by the substances deposited slowly and gradually by the waters, or by soil gained at the time of great floods. We

daily see little hills formed in this manner, which are always of a small height compared with those of the first order, and round in the top, or covered with soil frequently forming a pretty flat and extensive surface. We there find likewise sand and heaps of round pebbles, like such as have been worn by the waters. The internal part of these mountains consists of a heap of strata almost horizontal, and containing a prodigious quantity of shells, marine bodies, and fish bones. Although these mountains formed by strata sometimes degenerate into little hills, and even become almost flat, they always consist of an immense collection of fossils of different kinds, in great preservation, and which are pretty easily detached from their earthy bed whether harder or softer. These fossils, consisting of marine shells intermixed and confounded with heaps of organized bodies of another species, present a picture of astonishing disorder, and give indubitable indications that some extraordinary and violent current has confounded and accumulated in the greatest disorder and precipitation foreign substances and shells of various kinds. These, removed from their natural and original place, by their union, form an elevation and a mountain, which are in fact nothing but a composition of the wrecks of bodies formerly organized. All these phenomena seem to prove, that most of these mountains chiefly owe their origin to the sea, which once covered some parts of our continent, now left dry by its retreat. (According to the principles of this system, Anaxarchus explained the formation of the mountains of Lampsacus.) In these mountains we likewise find wood, prints of plants, strata of clay, marl, and chalk, different beds of stone succeeding one another, such as slate, marble which is often full of sea-shells, lime-stone which appears to be wholly formed from the wreck of shells, plaster-stone, entire strata of ochre, and beds of bitumen, mineral salt, and alum.

The strata of mountains which are lower and of a recent date, or formed by recent accidents, sometimes appear to rest upon, or to take their rise from, the sides of primitive mountains which they surround, and of which they in some measure form the first steps in the ascent; and they end by being insensibly lost in the plains. With respect to the irregularity of some strata in recent mountains, it is owing to violent and sudden inundations, to torrents, and to local revolutions which have produced angles, leaps, and sinkings down of the strata.

A very ingenious writer, Dr. Kirwan, has lately published an interesting essay on the declivities of mountains, from which we present our readers with the following observations :

Among the various causes to whose activity the planet we inhabit owes its present wonderfully diversified appearance, some undoubtedly exerted their influence from its very origin, and others at subsequent periods; of these last, one at least, namely, the Noachian deluge, was universal in its operation, while the effects of many more were partial and local, such as those resulting from earthquakes, volcanos, particular inundations, &c.

In a general survey of the globe, it is only to general causes, whose operation was universal, that our attention can be directed; the effects of partial causes being the proper objects of the geological history of those countries that were particularly affected by them.

But to distinguish causes of the former class from those whose operation was more confined, it is necessary to discover some character by which their effects may unequivocally be discerned.

Now a general uniformity, or agreement in some particular circumstance in every part of the globe, seems to be a sure test of the operation of some general cause. The discovery of uniform appearances is therefore of primary importance in geological researches. In the essay before us, Mr. Kirwan confines himself to an investigation of one instance of this sort, namely, the inequality of declivity which the sides or flanks of mountains exhibit in every part of the globe hitherto examined according to the points of the compass to which they face, and are exposed.

That onepart ofalmost every high mountain or hill is steeper than another, could not have escaped the notice of any person who had traversed such mountains; but that nature in the formation of such declivities had any regard to different aspects or points of the compass, seems to have been first remarked by the celebrated Swedish geologist Mr. Tilas, in the 22d. vol. of the Memoirs of Stockholm for 1760. Neither Varenius, Lulolph, nor Buffon in his Natural History published in 1748, have noticed this remarkable circumstance.

The observation of Tilas, however, relates only to the extreme ends, and not to the flanks of mountains; with respect to the former, he remarked, that the steepest declivity always faces that part of the country where the land lies lowest, and the gentlest that part

of the country where the land lies highest, and that in the southern and eastern parts of Sweden they consequently face the E. and S. E. and in the northern the W. The essential part of this observation extends therefore only to the general elevation or depression of the country, and not to the bearings of these declivities.

The discovery that the different declivities of the flanks of mountains bear an invariable relation to their different aspects, seems to have been first published by Mr. Bergman in his physical description of the earth, of which the second edition appeared in 1773. He there remarked, that in mountains that extend from N. to S. the western flank is the steepest, and the eastern the gentlest. And that in mountains which run E. and W. the southern declivity is the steepest and the northern the gentlest, vol. 2d. § 187.

This assertion he grounds on the observations related in his first vol. § 32, namely, that 1° in Scandinavia the Suevoberg mountains that ran N. and S. separating Sweden from Norway, the western or Norwegian sides are the steepest, and the eastern or Swedish the most moderate, the verticality or steepness of the former being to that of the latter as 40 or 50 to 4 or 2.

2dly. That the Alps are steeper on their western and southern sides than on the eastern and northern.

3dly. That in America the Cordelieres are steeper on the western side, which faces the Pacific Ocean, than on the eastern. But he does not notice a few exceptions to this rule in particular cases which will hereafter be mentioned.

Buffon, in the first vol. of his Epochs of Nature, published in 1778, p. 185, is the next who notices the general prevalence of this phenomenon, as far as relates to the eastern and western sides of the mountains that extend from north to south, but he is silent with respect to the north and south sides of the mountains that run from east to west; nay, he does not seem to have had a just comprehension of this phenomenon, for he considers it conjointly with the general dip of the regions in which these mountains exist. Thus he tells us, vol. 1st, p. 185, that in all continents the general declivity, taking it from the summit of mountains, is always more rapid on the western than on the eastern side; thus the summit of the chain of the Cordelieres is much nearer to the western shores than to the eastern: the chain which divides the whole length of Africa, from the Cape of Good Hope to the mountains of the

Moon, is nearer, he says, to the western than to the eastern seas; of this however he must have been ignorant, as that tract of country is still unknown.

The mountains which run from Cape Comorin through the peninsula of India are, he says, much nearer to the sea on the east than on the west; he probably meant the contrary, as the fact is evidently so, and so he states it in the 2d vol. p. 295; the same he tells us may be observed in islands and peninsulas, and in mountains.

This remarkable circumstance of mountains was notwithstanding so little noticed, that in 1792 the author of an excellent account of the territory of Carlsbad in Bohemia tells us he had made an observation, which he had never met with in any physical description of the earth, namely, that the southern declivity of all mountains was much steeper than the northern, which he proves by instancing the Erzgebirge of Saxony, the Pyrenees, the mountains of Switzerland, Savoy, Carinthia, Tyrol, Moravia, the Carpathian and Mount Hæmus in Turkey.

Herman in his Geology, published in 1787, p. 90, has at least partially mentioned this circumstance; for he says that the eastern declivities of all mountains are much gentler and more thickly covered with secondary strata, and to a greater height, than the western flanks, which he instances in the Swedish and Norwegian mountains, the Alps, the Caucasian, the Appennine, and Auralian mountains; but the declivities bearing a southern or northern aspect he does not mention.

La Metherie, in the 4th vol. of his Theory of the Earth, of which the second edition appeared in 1797, a work which abounds in excellent observations, p. 381, produces numerous instances of the inequality of the eastern and western declivities, but scarce any of the northern and southern, whose difference he does not seem to have noticed; but he makes a remark which we have not seen elsewhere, that the coasts of different countries present similar declivities.

With regard to eastern and western aspects, he thinks that a different law has obtained in Africa from that which has been observed in other countries, for in that vast peninsula he imagines the eastern declivities of mountains are the steepest, and the western the gentlest. Of this however he adduces no other proof, than that the greatest rivers are found on the western side: this proof seems in-

sufficient, as, if mountains be situated far inland, great rivers may flow indiscriminately from any side of them, and sometimes few rivers flow even from the side whose descent is most moderate, for instance, from the eastern side of the mountains of Syria; the Elbe and the Oder, two of the greatest rivers in Germany, take their course from the western sides, the first of the Bohemian and the other of the Moravian mountains, which yet are the steepest. Many originate from lakes, as the Shannon with us; many take such a winding course, that from a bare knowledge of the place of their disemboguement it is impossible to judge from what side of a mountain they issue, if from any; their course at most discovers the depression of the general level of the country.

In 1798, the celebrated traveller and circumnavigator, John Reinhold Foster, published a geological tract which merits so much more attention, as all the facts were either observed by himself, or related to him by the immediate observers. In this he states as a fact universally observed, that the south and south-east sides of almost every mountain are steep, but that the north and north-west sides are gently covered and connected with secondary strata in which organic remains abound, which he illustrates by various instances, some of which have been already, and others will presently be mentioned.

At present this fact attracts the greatest attention, being obviously connected with the original structure of the globe, and clearly proving that mountains are not mere fortuitous eruptions unconnected with transactions on the surface of the earth, as has of late been confidently advanced. [*Pantologia.*]

SECTION II.

Chief Mountains of Europe.

AMONGST the most considerable mountains in Thessaly and Macedonia, we may reckon that great ridge running across the north part thereof, called the Scardian mountains. In this part of Macedon stood also Mount Pangæus, lofty, and well covered with wood, yet infinitely more valuable from its mineral contents, which were both gold and silver*: Hæmus, or rather Aemus, the western spurs of which, joining the Scardian hills, divide this country from Thrace†: and

* Plin. hist. nat. l. iv. c. 11. Dion. Cass. l. xlvii. p. 347.

† Plin. hist. nat. lib. iv. c. 11. Diod. Sicul. lib. iv. c. 84.

Athos, in the Chalcidian region, one of the most celebrated mountains in the world *. Mela reports, that this latter is so high, as to reach above the clouds †. Martianus Capellus affirmed it to be six miles high ‡; and it was a received opinion, that no rain ever descended upon it, because the ashes left on the altars erected near its summit were always found as they were left, dry and unscattered.

But if, on many accounts, this mountain was famous among the antients, it is no less so among the moderns. The Greeks, struck with its singular situation, and the venerable appearance of its towering ascent, erected so many churches, monasteries, and hermitages thereon, that it became in a manner inhabited by devotees, and from thence received the name of the Holy Mountain, which it still retains, though many of those consecrated works are now decayed. Mount Athos is thought to have received its name from a giant, who, the scholiast on Theocritus informs us, was the son of Neptune and Rhodope; but in this there is a concealed meaning; for he is said to have removed this mountain from the neighbourhood of a lake of the last-mentioned name, and hence he is called the son of Rhodope, because he came from her; and the son of Neptune, because he came to him. There are coins, which, on their reverse, have the summit of mount Athos, with a man of gigantic size lying on the rocks, with his right hand over his head. Whether this be the Giant, the Genius of the Mountain, or Jupiter Athous, is not clear §. Herodotus gives us the following description of the mountain: "Athos is a mountain of great fame and magnitude, leaning upon the sea, and well inhabited. It terminates to the landward in the form of a peninsula, and makes an isthmus of about twelve stades in length, containing a plain, with some mixture of little hills from the coast of Acanthus to that of Torone. On this isthmus, which lies at the foot of mount Athos, stands Sana, a Grecian city; but Xerxes determined to cut off from the continent all the other cities, which, built upon the mountain, and beyond this place, were Dion, Olophyxus, Acrothoon, Thysus, and Cleone ‖." From Thucydides we learn, that the inhabitants of the five cities were barbarians, speaking two different tongues; that is, the Greek, and a language of their

* Herodot. lib. vii. c. 22. Plin. nat. hist. l. iv. c. 11.

† De situ orbis, l. ii. c. 2. ‡ Ap. Varen. geogr. l. i.

§ Gronov. antiq. Græc. vol. i Tit. Athos. ‖ Herodot. l. vii. c. 22.

own. Plutarch and Pliny have both written, that this mountain is so high, as to project its shade, when the sun is in the summer solstice, on the market-place of the city Myrrhina in the island of Lemnos. On account of this it is said, that the inhabitants of this city erected a brazen calf at the termination of the shadow, on which was inscribed this monostich:

Ἄθως καλύψει πλευρὰ Λημνίας βοός.
Half Lemnos' calf doth Athos shadow hide.

Pliny asserts the distance between the foot of mount Athos, and the island of Lemnos to be 87,000 paces. He does not tell us at what hour of the day this shadow was observed, yet this may be supplied by supposing it to have been a little before sun-set; the sun being then in the vertical circle, which passeth over Athos and Myrrhina; or rather, it may be supposed two degrees higher, because otherwise the shadow could not be so exactly observed in Lemnos *. These points settled, it would appear from the principles of trigonometry, that the altitude of Athos is thirty-two furlongs, which, however, is not very consistent with truth. The reason in all probability is, that Pliny hath assigned too great a distance between the mountain and the island. The best maps we have make that island but fifty-five Italian miles; which being assumed, reduces it nearer the true height, viz. of eleven furlongs, or a little more †.

As to the modern state of this celebrated mountain, we cannot inform the reader better thereof, than by translating the accurate description of an early French traveller: " As I staid a good while at Salonichi, and as this city is not far distant from Monte Santo, which is Mount Athos, so much celebrated by the ancient poets for its height, and so famous among the modern Greeks, for the monks and hermits residing thereon, I could not be satisfied without going to see it. In the space of a few days I examined this wide and celebrated wonder, leaving no part of it unexplored, no not even the chapel on the summit, which is very little visited. As I ascended, I found a good deal of snow; but as it was in the finest season of the year, (in the month of June) the sun began to operate upon it every-where, and to turn it into water. Its summit is a perfect rock, and absolutely naked; but the snow did not lie there

* L. iv. c. 12. p. 58.

† Varenius's Geography, vol. i. p. 12.

so long as in the vallies. Passing to the south side, we found it shady. Arriving at the chapel, which was seated on a high rock, we were informed, that it was consecrated in memory of the transfiguration, and that on the sixth of August they sung a solemn mass in the presence of a multitude of people, who out of devotion remained there all night. As to other things, we found them in pretty good order, considering it is a place not to be visited but in summer-weather. The building too was well enough, especially if we consider its situation, it being not a little surprising to find a chapel erected, where one cannot stay a quarter of an hour without a great fire. That which our geographers call Monto Santo comprehends not only mount Athos, but the whole chain of mountains, which unite it to the continent of Macedonia. This chain is seven or eight leagues long, and three or four broad: and it is true, that the Greeks call this ridge Oros Agion, or the Holy Mountain; but when they speak of Mount Athos in particular, they call it still Athos. Of the twenty monasteries erected in this solitude, there is but one, which stands on this mountain, and that is dedicated to St. Laura, which is is indeed richer and more considerable than all the rest; and it is owned, that from the monks inhabiting therein, the rest took the rule under which they live. These convents, generally speaking, resemble fortresses rather than religious houses. They are surrounded with good walls, flanked with towers, or at least surmounted by a vast donjon, well furnished with artillery, and all things else necessary for defence. This is a very necessary precaution, considering their situation in the midst of thieves. As these monasteries are generally five or six stories high, the apartments in them are numerous, and very large, but not over well disposed. They are covered with lead, which, by the reflexion of the sun-beams, shine like silver; and, all things considered, we may rather wonder at their being in so good state, than at their being in no better. These monasteries are independent of each other in point of government; and though in the centre of these monasteries there is an episcopal see, in a pretty large town called Kapiarb, yet the monks pay no sort of obedience to this bishop. The cathedral, however, is stiled Acrotaton, i. e. the most high, and is served by monks sent by the superiors of the respective convents for that purpose. There is also on mount Athos a considerable church, dedicated to St. Anne, where the

Anchorites resort for the performance of their devotions at certain festivals, and other settled times. These poor people are quite secluded from the rest of the human race. They may be about sixty in number, and live most of them alone; the rest, two in a cell; they live by the labour of their hands, as did the ancient monks, and are under the direction of a chief, who is called Dicaios, i. e. the Just; yet he himself is dependent on the monastery of St. Laura, because their cells are built on the ground belonging to that religious house. All the monasteries have little farms belonging to them, which are managed by certain monks for the benefit of the house. All these religious, as has been said before, live under a common rule; which rule consists chiefly in the strict observance of the following points: 1. The keeping certain stated fasts, which they recommend vehemently in their sermons, and which, to do them justice, they recommend no less by the severity with which they keep them. 2. The passing whole nights in certain churches consecrated to the honour of God, where they either make solemn prayers, or else join together in chanting psalms, conforming herein to the practice of the ancient church, in which these devotions were stiled vigils. 3. They suffer no woman to approach the holy mountain, which they carry yet farther, by excluding all kind of animals of the feminine gender; and on this principle they were wont also to cause their younger monks to be instructed in separate houses, as if youth itself had something in it feminine *."

As Athos astonished by its height and bulk, the mountain Olympus struck the beholder with reverence by its amazing loftiness; and at the same time invited his ascent by the beauty and variety of prospects which it afforded. The river Peneus, one of the clearest, gentlest and most beautiful streams in the universe, washed its foot, dividing it from Ossa, and making a multitude of small but charming isles, covered with shady trees, and adorned with magnificent temples, grottoes, porticoes, and other stately buildings †. Its height is certainly very great; but, as we have already observed not near so great as it was imagined by the ancients. As to the notion of its being above the second region of the air, it depended intirely upon the fact, that letters traced on the ashes of Jupiter's altar, remained undefaced for a long space of time. This altar stood on the very sum-

* Voyages du Sieur P. Lucas, t. i. p. 206.

† Tempe, secund. descript. Ortelii.

mit of Olympus, and the god was worshipped there with peculiar devotion On the south east side of the hill ran the famous river Helicon, and near it stood a noble temple of Jupiter, in the midst of a shady grove. The mountains Ossa and Pelion were in its neighbourhood, much spoken of in ancient authors, and very considerable for their height, though they come far short of Olympus. Dicæarchus Siculus at the command of some of the neighbouring princes, measured mount Pelion with great exactness, and found it to be in height 1250 paces, or about an Italian mile and half. It is now called Petras, and has some little forts on its sides *. There is some doubt amongst geographers, whether this region ought to be reckoned to Macedonia or Thessaly: but as we make the river Peneus their common boundary, Olympus * and its immediate vicinity belongs, in our estimation, to the former. On account of the great height of Olympus, or Lacha, as it is now denominated, the ancient poets feigned it to be the seat of the Gods. Xenagorus however reduced it to actual measurement, and ascetained that its real height did not much exceed the amount of an English mile. It was at the foot of this mountain that the Olympic games, so highly and deservedly celebrated, were performed; and which by the punctuality of their recurrence served as a basis for ancient chronology.

The whole of this delightful country is in truth sacred ground. Adjoining mount Ossa is mount Nephele, both which are said to have been inhabited by Centaurs, which were slain by Hercules, or exiled from their native country. Here too are situated the immortalized plains of Pharsalia; while embossed between Olympus, Ossa and Pelion, lies the delightful valley of Tempe, so richly adorned with the gifts of nature, and so pleasantly watered, as we have already observed, by the transparent stream of the Peneus, the Salampisa of the present day. Nearly within sight rises also mount Hæmus, which joins the Scardi or Scardian hills, and separates the country fromR omania. The whole of this garden of the Muses is now under the barbarous dominion of the Ottoman Porte.

* Strab. Geogr. l. ix. p. 807. Virg. Georg. l. i. ver. 281. Varen. geogr. p. 118. Plin. hist. nat. l, iv.

† Olympus was a favourite name among the Greeks, and hence applied to other mountains besides the present; the chief of which was seated in Asia, not far from Pergamus. See section III. of the present chapter.

To the south of Janna is *Liordia,* another province of Turkey in Europe, constituting ancient Greece, properly so called, the capital of which is Setines, formerly the renowned city of Athens. In this district is the famous mountain, which in ancient times bore the name of PARNASSUS, and was in Phocis, but is now called *Parnasso,* and by the Turks *Licdora.* It has two heads, one of which the ancients consecrated to Apollo and the nine Muses, the other to Bacchus. Hence some ancient writers have given to the Muses the name of *Parnassides;* while Perseus gravely asserts, that if any person slept on that mountain, he soon after became a poet. In fabulous times it was called *Larnassus,* from Larnace, the ark of Deucalion, which was supposed to have rested upon it: after that deluge it was called Parnassus, from a man so named who inhabited it. Here is likewise a fountain, which is supposed to have been the Castalian spring of the ancients. Beside Athens, in this province were seated the cities of Thebes, Delphos, and Pithia.

The ancient HELICON, a mountain which appears to have received no modern name, rises in the vicinity of Mount Parnassus. Amidst the fabulous traditions of former times, and which have descended to the moderns, we find, that when Hercules cut off the head of Medusa, the blood which issued from the body was instantly converted into Pegasus, the flying horse of the Muses, which passing over this mountain, in his ascent struck it with his hoof, whence a fountain was opened which the Greeks called *Hippocrene,* and which was considered as the Muses' fountain, whose waters excited inspiration.

HÆMUS and RHODOPE, the former of which we have already glanced at, are two long ridges of mountains which extend from the frontiers of Macedonia to the Euxine or Black Sea. Rhodope was celebrated by the ancient poets on account of the catastrophe of Orpheus.

MOUNT IDA, so celebrated by the ancients, rises in the centre of the island of Candia, the ancient Crete, which was considered by the heathen mythologists as the birth-place of Jupiter. This island, one of the largest in the Mediterranean, is seated in a delightful climate, about 35° north latitude, to the south-east of the Morea, the ancient Peleponnesus, before the mouth of the Archipelago, almost equidistant from Europe, Asia, and Africa. Above half the island is covered with rocky, barren mountains, the most famous of which

Engraved by T.L. Busby, from a Drawing by Craig

for the Gallery of Nature & Art

MOUNT PARNASSUS.

London, Published by R. Wilks, 89, Chancery Lane, Mar. 1 1824.

is *Psiloriti*, the ancient *Ida*, the highest in the island. It is now one continued barren rock, and for the greatest part of the year has its summit covered with snow. Its only produce is the tragacanth, which is valuable on account of its gum. Ida commands a view of both seas: and the island has many springs and rivulets of excellent water, but no navigable river. Here too is *Lethe*, the river of oblivion, so much the subject of ancient story, which is a torpid stream.

The CRAPAC, or CARPATHIAN, mountains separate Poland from Hungary (the ancient Pannonia) and Transylvania. The base of these mountains is overspread with wood; the ascent produces trees of a much larger growth for a considerable way, then a third region is formed, consisting of brush-wood, whilst the summits are barren, rude and wild; terrifying the boldest visitants with the appearance of horrid crags, and frightful precipices covered with snow, yet interspersed with lakes of most transparent water. In the district of Sips, in the division of Upper Hungary, the Carpathian mountains reach their utmost height. Here too are various other remarkable mountains, especially the Ochsenberg, and Konigsberg or King's mountain, so called from King Matthias Corvinus, who in the year 1474, dined on its summit.

In Silesia, the principality of *Jauer* is in general mountainous, and is separated from Bohemia to the south and west by a chain of mountains. The *Schnee* or *Riesenkoppe* is the highest of all the *Riesen*, or *Giant's Chain*, as well as the loftiest part of all Silesia. It raises its head far above any of the neighbouring mountains, and for the greatest part of the year is covered with snow. Those who have climbed it, compute its ascent from the foot to the highest summit at three German miles; and the Rev. Mr. Schilling, rector of Hirschberg, is said to have discovered, by means of mathematical instruments, that its perpendicular height is no less than twenty-two thousand five hundred Rhineland feet; but this account is certainly erroneous; for were it of such a height, it would be perpetually covered with snow, and the cold would be much more intense than it really is. Its loftiest part is a steep stony rock of considerable circumference, upon which is built a chapel, wherein mass is celebrated five times a year.

The FICHTELBERG mountains are the highest in Germany, and stand in the principality of Culembach, extending nineteen miles

from north to south. It receives its name from the great number of pines with which it is covered, *fichte* signifying a pine, and *berg* a mountain; it also produces firs and beeches, and in some places oaks, elms, and lime trees. From these woods the peasants that live about the mountain derive most of their subsistence by making charcoal, and in winter bringing down the timber in sledges to sell. This loftiest of the mountains of Germany, contains many elevated rocks and deserts, and a number of bogs and morasses.

The ALPS are the highest mountains in Europe; or rather they are a long chain of mountains that begin at the mouth of the river Var, and, after many irregular windings, terminate near the river Arsia, in Istria. They divide Italy from France, Swisserland, and Germany, and are variously denominated, according to their situation. The Alps on the sea coast, or *Maritime Alps*, reach from Vada, or Vado, to the source of the Var, or even that of the Po; the *Cottian Alps*, from the source of the Var to the city of Susa; the *Greek Alps*, from the city of Susa to Mount St. Bernard; the *Peninian Alps*, from Mount St. Bernard to Mount St. Gothard; on these border the *Rhætian Alps*, which extend to the source of the river Piava; and lastly, the *Noric*, or *Carnician Alps*, extend from the river Piava to Istria, and the source of the Saustrum. Livy supposed them to measure two thousand stades (furlongs) in length, or two hundred and fifty miles; and his description of Hannibal's attempt to cross them, in the winter season, to invade Italy, records a very interesting event in the Roman history. In the valleys lying between these mountains *Swisserland*, or *Switzerland*, the *Helvetia* of the ancients, is situated, which is the highest country in this part of the world; and, though lying between 45° and 48° of north latitude, having the air much sharper than in more northern latitudes. The Alps are composed of stupendous rocky masses, chiefly of granite and gneiss, two, four, and even six, being piled on each other, and from four to twelve thousand feet high. The peak of mount Gotthard, is, by du Cret, computed at sixteen thousand five hundred French feet. The lower parts of these high mountains are covered with woods and pastures, the herbage in which is of a remarkable length and richness. The middle abounds with a great variety of odoriferous herbs, thickets, bushes, and excellent springs, which, in summer, are resorted to by herdsmen with their cattle. The third part

of these mountains almost entirely consists of craggy and inaccessible rocks, some of which are quite bare, without the least herbage growing upon them, while others are continually covered with snow or ice. The vallies between these icy and snowy mountains appear like so many smooth frozen lakes; while vast fragments of ice frequently fall down from the mountains into the more fruitful spots beneath. It is from these masses, and the thawing of the ice and snow, that the greatest part of the streams and rivers in Swisserland are derived. The ice-hills begin in the canton of Glaris, and after passing through the territory of the Grisons, and thence into the canton of Uri, terminate in the district of Bern. The most lofty of these mountains are those in the canton of Uri, namely, *St. Gotthard, Furka, Crispalt,* and *Luckmanier*, which send forth rivers to all the principal quarters of Europe. The loftiest of the whole chain, according to Saussure, are Mount Blanc, Titlis, to the north of Furka, Schreckhorn, and Finsteraar, to the south of Sechreckhorn. Mount Blanc rises in its summit to 147,000 French feet; or 15,662 English, according to the measurement of Sir George Shuckborough; Titlis is 10,818 above the level of the sea; and the two last are at least 2,400 feet higher.

This is the most dreary part of all Swisserland; for on the summits of these mountains an intense cold almost constantly prevails, with hard gales of wind, and very damp fogs; while the valleys, except various towns and villages, with a few fields and vineyards, thick woods, and rich pastures, are covered with lakes; and here the summer heats are frequently so insupportable, that the inhabitants betake themselves to the mountains, though in winter their houses are almost buried in snow. In many places, within a small compass, the four seasons are seen at once; and sometimes summer and winter are so near each other, that one hand may take up snow, and the other pluck flowers.

During the greatest part of the year the clouds hang beneath the peaks of the highest mountains, and resemble a sea, from which the peaks rise like islands. Sometimes they break, and thus display a view of the extensive country beneath. From the rising and sinking of these clouds, the inhabitants form pretty certain conjectures with respect to the weather. Not one of the above mountains is without a cataract, and as the eye, in consequence of the intervention of the

clouds, is not always able to trace their origin, they look as if poured down upon the rocks from heaven.

The water thus falling from one rock to another, makes an astonishing noise, and raises a mist around it, on which when the sunbeams play, is formed a most beautiful spectacle, particularly at the foot of the cataract, where those beams exhibit rainbows of the most lively colours.

Among these mountains are many medicinal springs, some of which form cold, and other warm baths, celebrated for different and extraordinary virtue.

Five leagues to the southward of Geneva is an elevated spot called *La Dole,* from which may be seen, at certain times, in fine weather, seven different lakes, viz. that of Geneva, Annecy, Rosses, Bourget, Joux, Morat, and Neufchatel, besides a long chain of the Alps, and an extent of one hundred leagues quite into Dauphiné, a view more extensive and stupendous than any other part of the world exhibits. On the summit of la Dole is a noble terrace formed by the hand of Nature, where, from time immemorial, the young people of the country have assembled in great numbers, on the two first Sundays in the month of August, taking with them all sorts of refreshments, and spending the days in various sports and pastoral amusements.

The Savoyards, from the nature of their country, are generally so poor, that a traveller meets few people in the public road who do not recommend themselves to his benevolence; and a farmer with a yoke of oxen, two horses, four cows, a few goats and sheep, and a small parcel of land, is esteemed a man of considerable fortune. Their bread is of oats; but the more wealthy use some wheat. Their other food consists of butter, cheese, walnuts, vegetables, and sometimes, though seldom, flesh meat; and their drink is milk and good water. However, those who live in the valleys live somewhat better. They are all cheerful, have healthy florid complexions, and are remarkable for their fecundity. Among both sexes, however, in some peculiar spots, many are seen deformed and lame; and the women in particular have wens that reach from ear to ear, which are called *goitres*, the cause of which has never been satisfactorily explained. One-third at least of the males seek a subsistence in France, and other countries, in qualities of chimney-sweepers, shoe-blacks, raree-shew

men, livery servants, &c. yet they are so honest, that they may be safely trusted; and if they are once able to set up a little shop, they are such masters of the thriving talents, that they often acquire very considerable fortunes; yet so prevalent is the love of their country, that when they have acquired a little stock abroad, they generally return home, and are incapable of enduring an absence from it.

The inhabitants of *Mount Cenis*, in Savoy, and the neighbouring mountains, which are parts of the Alps, are called *Marrons*, or *Marroniers*. "One would imagine," says Keysler, "that from the heavy burdens they daily carry up these steep mountains, they would soon or late fall into consumptions; but such is the effect of custom, and of simple diet, that many of them attain to above an hundred years of age."

And here it may not be unacceptable to present the reader with the substance of the Earl of Corke's animated description of the manner of passing the Alps, in a letter to the late Mr. Duncombe.— "At the foot of Chamberry commences the Alps. The ascent of the first mountain is very steep, but well paved, and sufficiently broad. A pair of oxen is constantly added to the chaise-horses; but in the subsequent mountains, which are many, all as steep, and several of them narrower, and worse paved than the first, no oxen are to be found. Over different parts of these we had recourse to our own feet. Three days were thus passed in ascending and descending these towering hills; our lodgings at night were worse than indifferent. The third evening brought us to a little village called *Lanebourg*, where our chaises were taken to pieces, and all preparations made for the atchievement of the next morning, the passage over Mount Cenis. The accounts which had been given me of this mountain had magnified the object to such a degree, that when I viewed it with my naked eye, it appeared much less dreadful than I had supposed it. Height is not tremendous; horror is not unusual; the most amazing circumstance is the manner of conveyance. It was difficult not to feel some uneasy sensations when we first entrusted our limbs and lives to the power and management of that particular species of animals, the *Alpian chairmen*. Some few minutes passed in fears, till we perceived our porters strong as giants, and nimble as racers. They did not miss a single step: they trod firm upon tottering stones: they jumped from one stone to another with the agility of goats. In little more than two hours

we found ourselves on the top of the mountain. The ascent is five miles continued, and so steep, that no carriage can pass. The plain upon the top is five miles over; every inch smooth and green as a sheep walk. In the middle of it is a large lake, from which arises the river Doria, which runs to Turin, and, in conjunction with the Po, supplies that city with water. The descent is five miles, but not continued, therefore it appears less steep. In the middle of it lies the town of *Santa Croce* (Holy Cross), where the principality of Piedmont begins. The prospect on each side, of tall firs, chesnuts, and larch-trees, of vast natural water-falls, and of roaring mountain rivers, affords such a surprising variety, as is at once awful, pleasing, and beyond description in any language whatever. The Piedmontese conveyed us down with the utmost swiftness, steadiness, and ease. In the windings of the hills, which are many, they shewed great dexterity, and seemed to go on purpose to the very brink of precipices, only to convince us that they could turn to an hair, and carry to an inch. At a little town called *Novelezza*, the scattered limbs of our chaises, which from Lanebourg had been carried upon mules, were, by a kind of Medean art, joined together again, and again our baggage was strictly searched at the custom-house, the tormenting obstruction of every little territory through which we passed."

In winter the plain on the top of Mount Cenis being covered with snow, is crossed in sledges drawn by a horse or a mule. The descent is in some places always performed in chairs; but from Mount Cenis and Lanebourg it is conducted in a very extraordinary manner. On the spot where the declivity begins is a house called *la Ramasse*, where the traveller getting into a sledge, with his guide, slides down with such swiftness, that he is carried about three miles in seven or eight minutes, the rapidity of the motion almost taking away his breath. The guide sits forward, steering with a stick, and has on each side an iron chain, which he drops like an anchor, either to slacken the course of the sledge, or to stop it. Travellers having been sometimes much imposed upon, the King of Sardinia has laid a tax on all kinds of carriages over this mountain; and on both sides is an officer, to whom strangers, in case of any imposition, may apply for redress.

Savoy seems sequestered from all incentives to luxury and softness, by lofty barren mountains and enormous rocks, by which the

Engraved by Scott, from a Drawing by Clennell. | for the Gallery of Nature & Art.

VIEW OF THE GLACIERS IN THE GRINDELWALD, SWISSERLAND.

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greatest part of it is overrun, and which are known to produce chiefly some moss, small shrubs, and box-trees. The vallies between the mountains yield some grain, but abound more in pasture; for the industry of the inhabitants has made the best improvements in the mountains themselves which the soil would admit of.

Some of the highest of these mountains are called *Glacieres*, or Ice Valleys, and *Montagnes Maudites*, or Cursed Mountains, in Faucigny; the perpendicular height of the latter, from the surface of the lake of Geneva, has been computed to be at least two thousand fathoms, which are equal to twelve thousand eight hundred and sixteen feet, or above two English miles; and the surface of the lake of Geneva is four hundred and twenty-six fathoms higher than the level of the Mediterranean. The ascent to these mountains is very steep, craggy, and slippery, but not continued; a new ridge of mountains frequently appearing on the other side, higher and more steep than that which is left behind; till at length, from the last eminence to be surmounted, the prospect of the frozen valley appears in full view, and on the opposite side a chain of craggy, inaccessible rocks, covered with ice and snow, and so scarped and split, that at some distance they look like prodigious piles of Gothic buildings and ruins, while the surface of the frozen valley below seems speckled, if we may thus express ourselves, with rocks of a monstrous size, that are broken off, and fallen from the higher grounds. Here the air is so extremely cold and piercing, that the months of July and August are only fit for this journey, and even at that season travellers are obliged to go cloathed as in the depth of winter.

The canton of Glaris is environed to the east, south, and west, by mountains of so great a height, that they are continually covered with ice and snow, particularly by the *Todiberg*, which is esteemed one of the highest in all Swisserland, and is almost impassable, notwithstanding a road has, with severe labour, been made over it from the great vale in Glaris to the country of the Grisons. From the north, where the country is open, a valley extends to the length of eight hours journey; but below Schwenden, the mountain named *Freyburg* divides into two separate vales, the greater and the less; the former of which lies to the west, and the latter to the east: besides which, there are several other vallies among the mountainous ridges.

Though these vales are in many parts extremely well suited for agriculture, very little grain is sown in them, the inhabitants being

chiefly employed in grazing horses and sheep on the Alps; and here they also feed many thousand heads of horned cattle, with which they carry on a profitable trade; they likewise export cheese, butter, and tallow. On these mountains are large woods of pines, with crystal pits. The high mountain named *Blattenberg* yields vast quantities of slate, which being polished, and formed into tables, or put into wooden frames for writing, are exported to all parts of the world. Of all the mountains in Swisserland, that named Freyburg affords the safest refuge for the chamois goats; only twelve sworn hunters being permitted to shoot them, and these at no other time than between St. James's day and Martinmas.

A chain of mountains called JURA rises in the canton of Zurich, continues through the canton of Soleure and the principality of Neufchatel, separates the Pays de Vaud from the eastern border of France, and is extended along the frontiers of the Genevois, as far as the Rhone. In the Pays de Vaud these mountains contain many elevated vallies, which greatly attract the notice of travellers, particularly the valley of the lake of Joux, situated on the summit of that part of the Jura which is called Mount Joux, where are several neat and populous villages, the number of inhabitants on this spot being rated at three thousand; the adjacent parts are diversified with wood and cultivated land both pasture and arable; to complete the beauties of this scenery there are two lakes, the largest of which is called the lake of Joux, the smaller lake Brenet; separated from each other by a narrow neck of land. The happy natives of this charming vale are occupied as artificers in various branches, such as watch-making, and polishing many kinds of stones. More than one third part of the whole population bears the surname of Rochat, and have sprung from one family which formerly settled here from France, probably driven from their native country by persecution. The descent from this very picturesque vale is through a great variety of captivating scenery, consisting of hills, valleys, wood, and lawn, commanding a very extensive prospect of a great part of the Pays de Vaud, with the lakes of Geneva and Neufchatel, blended with lofty mountains.

The Valais is a county of Swisserland, composed of one large vale extending east and west, but bounded on the north and south by very high mountains. Among the southern mountains, the most remarkable is that called Great St. Bernard's, anciently named Mons

Benninus, a name given to the whole Appennine chain. The principal hill on the north side is the Gemmi, which lies towards the frontiers of the canton of Berne; it is impassable in winter, and its descent toward the valley of the Valais was formerly of a dangerous steepness, and very narrow. To remedy this inconvenience, in 1736, more than a league of the hard rock was blown up with gunpowder, the road in most places widened to the breadth of seven feet, and walls raised in the steepest and loosest parts; so that travelling is at present much more safe and commodious than formerly. The whole was completed in five years: " an astonishing work," observes Mr. Coxe, " and proves that nothing is impracticable to human industry."

A country thus entirely inclosed within high Alps, and consisting of valleys, elevated plains, and lofty mountains, must necessarily exhibit a great variety of situations, climates, and productions. Accordingly, the Valais presents to the curious traveller a quick succession of prospects, as beautiful as they are diversified, numberless vineyards, rich pasture-grounds, covered with cattle, corn, flax, fruit-trees, and wild forests; and these occasionally bordered by naked rocks, whose summits are every where crowned with everlasting snow, and inaccessible glaciers. This strong and striking contrast between the pastoral and the sublime, the cultivated and the wild, cannot but affect the mind of an observer with the most pleasing emotions. The beauties and varieties of this country are amply and faithfully delineated by Rousseau, in his Nouvelle Heloise, in the character of St. Preux, where he relates his excursion into the Upper Valais.

The lakes on the north east side of which the city of Lucern stands, which is called in the maps by the name of that canton, is distinguished by some geographers as the Waldstœr See, or the Lake of the four Cantons, namely, of Lucern, Schwitz, Uri, and Underwald. MOUNT PILATE rises boldly on the side of this lake, and is perhaps one of the highest mountains in Swisserland, if estimated from its base, and not from the level of the sea. According to General Pfiffer, its elevation above the lake is more than six thousand feet; but its height above the Mediterranean is inconsiderable, when compared with that of some of the Alps more to the southward; nor indeed does the snow continue all the year upon its summit. It is a single insulated mountain, and

is divided at its top into two rugged points, which, when not covered with clouds, form a most majestic appearance.

The canton of *Uri* abounds with dreadful mountains, the summits of which are perpetually covered with ice and snow; these are separated by deep vallies. The loftiest among the mountains has been reckoned to be that of ST. GOTHARD, over which is carried a fine road in one continued ascent of eight hours (twenty-four miles) to its very summit. This road is in most parts six feet wide, and every where well paved during its whole ascent. The Russ, or Reuss, runs by its side, sometimes to the right, and at others to the left, over which are several handsome bridges, most of them of stone. This road in summer is perfectly safe, not only for horses, but even for carriages; though in winter the fall of masses of snow have proved fatal to many travellers. It forms one of the great passes into Italy. Several parts exhibit the most beautiful cataracts, either from the Russ, or other smaller streams; while many of them, by reason of the rocks that obstruct their passage, are resolved into a mist, which, by the refracting rays of the sun, form a variety of rainbows. The traveller, as he advances, is terrified at the view of frightful rocks hanging over the road, which seem threatening every moment to fall and crush him to atoms. Indeed, the industry and ingenuity of the inhabitants are here very conspicuous, who, at immense hazard, toil, and expence, keep these roads open. For this purpose, they join rocks together by arched bridges, cut a path-way through several rocks, and when the road seems ready to sink, support it by stout walls and buttresses, with great posts, which they drive deep into the earth, and stones, which they fasten to one another by iron cramps.

Mount Veso is among the highest of the Alps; and here the river *Po* has its rise.

The APPENNINE MOUNTAINS take their rise near the Alps, on the sea coast, in the territories of Genoa, and dividing Italy into almost two equal parts, reach to the straits which separate Naples from Sicily, and give rise to an incredible number of rivers that water this delightful country.

Of Etna and Vesuvius, we have already sufficiently treated; and shall only further observe, therefore, that the phenomenon of sun-rise, as surveyed from the former, is supposed by all travellers to constitute one of the most splendid spectacles in creation. "No

Engraved by Scott from a Drawing by Gennell. *For the Gallery of Nature & Art.*

VIEW OF THE DEVIL'S BRIDGE AND ITS ROCKS, ON MOUNT ST. GOTHARD.
in the Swiss Canton of Uri.

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imagination," says Mr. Brydone, "can form an idea of so glorious and magnificent a scene; neither is there, on the surface of this globe, any one point that unites so many awful and sublime subjects. The view is absolutely boundless on every side, nor is there any one object within the circle of vision to interrupt it, so that the sight is every where lost in the immensity; and I am perfectly convinced, that it is only from the imperfection of our organs that the coasts of Africa, and even Greece, are not discernible, as they are certainly above the horizon." The same writer supposes the horizon to extend four hundred miles, which makes eight hundred for the diameter of the circle, and two thousand four hundred miles for the circumference, a view too vast for human powers.

Among the many mountains in Spain, the PYRENEES are the most remarkable. These extend from the Mediterranean to the Atlantic Ocean, which is about two hundred and twelve miles, and in some places are above an hundred miles in breadth. They begin at Vendres, a sea-port in the province of Rousillon, in France, and extend to Fuentarabia, but under different names. Near Rousillon they divide themselves into two branches; that which separates the country from Languedoc is called *Antipyrenees*, the other, between it and Catalonia, *Col de Pertis*: between Gascony and Amazon lie the mountains of *Jaca* and *St Cristine*, and the famous *Pic de Midi*, which resembles a sugar-loaf standing on a table, and is of a prodigious height. In Navarre, between Pampelona and St. Jean de Pie de Port, are the mountains of *Adula* and *Roncevaux*. Over these mountains there are only five passages out of Spain into France, all of which are narrow; one of them leads from St. Sebastian's, in Guipuscoa, to St. Jean de Luz, the second from Maya, in Navarre, to Annoa, the third from Taraffa, in Navarre, to Pie de Port, the fourth through the county of Comminges, in Arragon, and the fifth from Catalonia to Languedoc. The vallies between these mountains are covered with thick and lofty woods.

The other mountains of Spain are *Sierra d'Occa*, or *Mount Idubeda*, which is a chain extending from the Pyrenees to Tortosa. At the commencement it forms an arm traversing all Spain from east to west, as far as Cape Finisterre. To the south, below Mount Cayo, another branch, called Orespeda, rises gradually, and near the source of the Tagus takes the name of

Sierra Molino, which, farther south, it changes for that of *Sierra d'Alcaraz.*

Here the chain turns off to the south-west, separating the kingdom of Granada, and extending to the straits of Gibraltar.

St. Jean Pied de Port, or " St. John at the foot of the gate," is situated at the entrance of the pass that leads through the Pyrenean mountains from France into Spain. It stands on the river Nive, twenty miles to the south-east of Bayonne, and has a citadel placed on an eminence that commands the post.

We may also be permitted to observe, though with a slight digression from our subject, that at the foot of the Pyrenees is the small island called *Faisan's,* or *Pheasants Island,* formed by the river Bidassoa, that separates France from Spain: an island which is worthy of notice, on account of the peace of the Pyrenees in 1659, and the treaty of marriage which were adjusted there by Louis XIV. and Philip III. in person, assisted by their two ministers, Cardinal Mazarine and Don Lewis de Haro, A. D. 1659; in consequence of which, Maria Theresa, Infanta of Spain, was espoused to the French monarch, which marriage eventually seated a branch of the house of Bourbon on the throne of Spain. The circumstances of this negociation are admirably related by Voltaire, in the fifth chapter of his *Siecle de Louis* XIV. In 1722, were exchanged at this place the Infanta Maria Anna Victoria and Madamoiselle de Montpensier, daughter to the Duke of Orleans, regent of France; it is hence called by the French *l'Isle de la Conference,* and *l'Isle de Paix.*

These and many of the preceding chains of mountains, serve to shelter great numbers of wild beasts, particularly wolves, which spread terror and devastation through their wild scenery.

By wintry famine rous'd, from all the tract
Of horrid mountains which the shining Alps,
And wavy Appennines and Pyrenees,
Branch out stupendous into distant lands;
Cruel as death, and hungry as the grave!
Burning for blood! bony and ghaunt, and grim!
Assembling wolves in raging troops descend;
And, pouring o'er the country, bear along,
Keen as the north wind sweeps the glossy snow.
All is their prize. They fasten on the steed,
Press him to earth, and pierce his mighty heart.

Nor can the bull his awful front defend,
Or shake the murd'ring savages away.
Rapacious at the mother's throat they fly,
And tear the screaming infant from her breast.
The godlike face of man avails him nought.
Ev'n beauty, force divine! at whose bright glance
The gen'rous lion stands in soften'd gaze,
Here bleeds, a hapless undistinguish'd prey.

The kingdom of Granada, in Spain, is very mountainous, particularly toward the sea, but is interspersed with delightful vallies. The LAS ALPUXARRAS are mountains of a prodigious height, inhabited by a Moorish race, who have embraced the Romish religion, but still retain their national customs and manners of living, and their language is a mixture of Arabic and Spanish. They are divided into eleven districts.

In PORTUGAL, the most southern province, which is called the kingdom of *Algarve*, or *Algarva*, is bounded on the north by the mountains of *Caldeiras* and *Monachique*.

The mountain of CINTRA, in the province of Estramadura, in Portugal, consists of large rocks of flint, some of which are ten feet in diameter, and lie on one another without any connection. It is also very rich in metallic ores, and produces many remarkable plants, and also a vein of loadstone. At the foot of the mountain of Cintra is a town of the same name, five leagues from Lisbon, which contains about one thousand nine hundred inhabitants, with four churches, and is defended by an old castle built in the Moorish taste. The air here is thought to be the best in all Portugal, a pleasant coolness prevailing at the time when the heat of Lisbon is extremely sultry. A late writer expresses himself thus concerning this mountain: "Nature here exhibits her beauties upon a very extensive scale. Here are stupendous rocks, wildly interspersed with wood and water. Well might the ancients call it the promontory of the moon *(Promontorium Lunæ)*. There is not another spot on the globe where astronomical observations might be made to greater advantage, whether we consider the great height, the serenity of the atmosphere, or the extensive horizon, joined to the most commanding and unbounded prospect of the great Atlantic Ocean immediately under it on the west; but here is a convent of stupid,

dull, ignorant monks, who are so far from looking upward, that they are bound by a vow of professional humility never to lift their eyes from the earth.

According to Strabo, this mountain was anciently called *Hierna*. "Nature," says a later traveller, "apparently threw up the mountain of Cintra as a formidable barrier to stay the waves of the Atlantic Ocean, and to mark the western termination of her works in the European world. The height of the loftiest part of it above the level of the sea is computed at upward of three thousand feet. Every morning its summit is inveloped in clouds, and in the evening, long after night has obscured the vallies, it retains some glimmering of day-light. On its apex is the monastery of the order of St. Jeronimo, whose western front strikes every spectator with awe, as it appears hanging over an assemblage of lofty rocks.

"On the western side of the mountain is a fine piece of antiquity, which is supposed to have been a Morisque bath: it is fifty feet long, by seventeen broad, the water is four feet deep, and neither increases nor diminishes in winter or in summer, though it has no apparent source; and notwithstanding it is never cleared, yet it is always transparent, and the sides and bottom are free from weeds or sediment, which, according to Vitruvius, are the surest signs of the salubrity of water.

"At the foot of the mountain of Cintra, contiguous to the village which bears its name, is a palace, where the royal family used formerly to reside during the summer season, on account of the amenity of the place, and salubrity of the air; for although it is but sixteen miles from Lisbon, yet it has been found to be eight degrees cooler in the month of July than that capital, notwithstanding which, the palace is now entirely deserted, nor has it been much frequented since the death of Alphonso VI. who ended his miserable life in it after a captivity of seven years; he died in 1669."

The chief mountains of France are the Alps towards Italy, the Pyrenees, which border on Spain, both which have been already described, and the Cevennes, in Languedoc, once remarkable for the meeting of the protestants, as the most secure retreat from the persecuting tyranny of the government.

In Alsace, now forming the departments of the Upper and Lower Rhine, is a chain of mountains named the Wasgau, in French the Vosge. This chain begins in the neighbourhood of Longres, and ex-

tending from west to east, separates the country of Burgundy, now divided into three departments, from Lorrain, consisting also, in the present day, of three departments, named Meurth, Moselle, and (from the mountain) Vosges.

In the county of Rousillon, now the department of the Eastern Pyrenees, are the mountains of Massane and Carrigou, the latter of which is said to be fourteen hundred fathoms in height. This country is on all sides environed with mountains; and the summer heats are so intense, that the inhabitants are almost universally swarthy and meagre.

The highest mountains in Auvergne are Le Pui de Dome, the perpendicular height of which is eight hundred and ten fathoms, the Cantal nine hundred and eighty-four, and Mont d'Or one hundred and thirty; the two latter are no less famous for the curious plants that grow on them. Auvergne is now divided into two departments, which are named, from the mountains, Cantal, and Puy de Dome.

[*Anc. Univ. Hist. Shuckborough. Coxe. Brydone. Costigan. Murphy. Saussure. Payne.*]

SECTION III.

Mountains of Asia.

In Asia Minor, or Natolia as it is now called, we meet with another Olympus, named by way of distinction, *Olympus Myssiorum*, or the Olympus of the Myssians, now *Keshik Dog*. It is one of the loftiest and most considerable in this quarter of the world, and is situated in 40°. N. latitude, longitude 99°. E. It is indeed of a prodigious height; its top is barren, and covered with perennial snow, from which the city of Constantinople is supplied with that article, although at the distance of one hundred miles. The middle of the mountain is planted with firs and other trees, and the vallies beneath abound with a variety of fruits, but the tyranny of the Turkish government restrains the inhabitants from sowing more corn than is necessary for their own consumption.

About two or three leagues distant from the foot of Mount Olympus, is Prusa, by the Turks called Bursa, the capital of Bithynia, as it was of the Ottoman empire before the capture of Constantinople. It is watered by so many springs, which descend from that mountain,

that almost every house has a fountain. The most considerable of these springs issues in a stream as large as a man's body, and being conveyed to the town by a marble aqueduct, is dispersed to every part of the city

In the same delightful region, and towards the east of Armenia, rises Ararat, which according to Turnefort, seems chiefly to consist of free-stone, or calcareous sand-stone. It is a detached mountain, with two summits, the highest being covered with eternal snow. In one of the sides is an abyss or precipice of prodigious depth, the sides being perpendicular, and of a rough, black appearance, as if tinged with smoke. The domain belongs to Persia.

Taurus, constitutes a chain of mountains, which rise in Coromania, a province of Natolia or Asia Minor, and extend to India; they are known by different names in different countries.

Lycia, at present called Mentiseli, is bounded on the N. and E. by Phrygia Major and Pamphylia; on the S. by the Mediterranean, and on the W. by Caria. The mountains which branch out of Taurus surround it on three sides, as does the sea on the fourth. The river Xanthus divides it into two. It has a remarkable mountain named *Chimæra*, about six miles from the sea; which has been celebrated by Virgil for its volcano, Æneid vi. 288.

——— Flammisque armata Chimæra.
And vain Chimæra vomits empty flame. DRYDEN.

Near which the Lycians built a city called Hephestiæ, and dedicated it to Vulcan. From the circumstance of its having lions at the top, goats about the middle, and snakes at the bottom, it is said the poets feigned the monster Chimæra, which they represent as having the head, body, and hind parts of those animals. Thus Hesiod, Theog. 323:

Προσθε λεων, οπιθεν δε δρακων, μεσσε δε
Λευκον αποπνειουσα πυρος μενος αιθομενοιο χιμαιρα

Lion in front, a dragon was its rear,
Its midst a goat, wild vortices of flame
Snorting tremendous. GOOD'S LUCRET.

Caucasus is another chain of mountains in Asia; they extend from the Euxine, or Black sea, to the Caspian. Their summits are covered with perpetual snow, but the lower parts are fruitful, pro-

ducing corn, wine, fruits, and gum; both hogs and horned cattle are bred here, and abundance of honey is procured. These mountains are inhabited by several distinct nations, each speaking a different language. Under the ancients it formed part of the Taurian chain. It formerly produced gold, and has still vestiges of silver, copper, and lead. Its composition is granite.

Sinai, a mountain of Arabia Petræa, in latitude 29° 2′ N. longitude 34° 15′ E. is situated in a peninsula, formed by the two arms of the Red Sea, adjoining mount Horeb, about two hundred and sixty miles S. E. of Cairo in Egypt. The summit of this mountain appears somewhat conical, and is not very spacious: the Mahometans, as well as the Christians, have a chapel here for public worship. Travellers are shewn the place where Moses received the Law, where he hid himself from the face of God, and where his hand was supported by Aaron and Hur at the battle with Amalek; together with several other places mentioned in the Sacred Scriptures, and with which they seem as well acquainted as if they had been present when these great events were transacted.

Libanus, or Lebanon, is a chain of mountains dividing Syria from Palestine. Their summits are so high as to be covered with perpetual snow, but below they are fruitful and pleasant. These mountains are celebrated in the writings of the Old Testament for their abundance of cedar trees, which supplied Solomon with the timber used in the building of the Temple; but late travellers who have visited Palestine, describe them to be entirely stripped of these ancient honours.

Tabor is a high, round, and beautiful mountain near Jerusalem, and affirmed to be that on which Jesus Christ was transfigured.—People are near an hour in ascending to the top, where they find a most fruitful and delicious plain, of an oval form, about two furlongs in length, and one in breadth. It is every where surrounded with trees, except towards the south, and was anciently encompassed with walls, trenches, and other fortifications, many remains of which are still visible. In several places are cisterns of good water; and near the plain are three caves, formed to represent the tabernacles Peter proposed to erect, when, beholding the glory of the transfiguration, he cried out, "Lord, it is good for us to be here, let us make three tabernacles, &c." The top of this mountain has a most delightful prospect. The north-west affords a view of the Mediter-

ranean, and all round are the fine plains of Galilee and Esdraelon. To the eastward is Mount Hermon, and at the foot is seated Nain, famous for our Lord's having restored in that village, the widow's son to life. Due east is the sea, or rather lake of Tiberias; and close to it a steep mountain, down which the swine ran, and perished in the water. Towards the north is what they call the Mount of the Beatitudes, a small rising, from which Christ delivered his sermon; near this little hill is the city of Saphet, standing upon a high mountain, which, being then in view, our Saviour may be supposed to allude to, when he says, "A city set on a hill cannot be hid;" and to the southward is a view of the mountains of Gilboa, fatal to Saul.

In the eastern parts of Asia are many mountains of great extent and height; among these the Gauts, or Indian Appennines, are particularly worthy of description. They stretch along the western or Malabar coast of the peninsula of India, at a distance of about seventy miles from the shore, but in some places they approach much nearer. They extend through thirteen degrees of latitude, from 21° north to Cape Comorin. In their course are several descents, and it is these paths or passes to which the term *gaut* properly applies *.

The mountain Putala, in Thibet, is distinguished for being the chief residence of the grand Lama; the principal city of the country, as well as the province, has the name of Lassa; but the grand lama does not live in it, his place of residence being one of the finest of the pagodas, which are very numerous, upon the mountain Putala. He sits cross-legged upon a large and magnificent cushion, placed upon a kind of altar, in which posture he receives the respects, or rather adorations, not only of the people of the country, but of a surprising multitude of strangers, who undertake long and painful journeys, to offer him their homage upon their knees, and receive his blessing. Bentink says, that above twenty thousand lamas reside in several circles that extend round the foot of this mountain, according as the rank and dignity they possess render them more worthy to approach the person of the sovereign pontiff.

On the tops of the mountains, trophies are erected to his honour, that he may preserve man and beast; and all the kings who pay obedience to him, before their inauguration, send ambassadors with

* See for an Account of Bessely Gaut, Section viii, of this Chapter.

rich presents to obtain his blessing, as the means of making their reigns happy and prosperous.

The mountains Fikoosan and Omine, in the island of Japan, are remarkable for the religious uses to which they are applied. The Japanese are as much inclined to make religious vows as to go in pilgrimage to holy places. Hence there are a great number of religious houses for both sexes, and of many different orders. Among these are the Jammaboes, a kind of hermits, who pretend to abandon their temporal concerns for the sake of those that are spiritual and eternal: yet such as can live at their ease dwell in their own houses, while the poor stroll and beg about the country. They have been divided into two orders, the Tosanfa and the Fonsanfa. Those who embrace the former class must once a year climb to the top of the mountain Fikoosan, a journey of no small difficulty and danger, on account of its height and steepness, and the many precipices all around it; and beside, it is imagined, that all who presume to ascend it with any degree of impurity, will be punished for their impiety by being struck with madness. On the other hand, those who enter into the order of Fonsanfa, must once a year go in pilgrimage to the grave of their founder, at the top of an high mountain named Omine, where the air is said to be excessive cold, and the steepness and precipices make its ascent no less dangerous than that of the preceding. These suppose that should any one undertake this journey without being sufficiently purified, he would be thrown down the horrid precipices, and dashed to pieces, or at least would pay for his contempt of the anger of the gods by a lingering sickness, or some dreadful misfortune. They therefore qualify themselves by previous mortifications, abstaining from impure food, and from whatever may render them defiled. While they are upon their journey, they must live only upon the roots and plants they find on the mountains. If they return safe home, they go each to the general of his order, who resides at Miaco, and make him a small present of money, which, if poor, they must procure by begging; and in return they receive from him a more honourable title, which occasions some alteration in their dress, and increases the respect shewn them by their brethren of the same order. Thus ambition is far from being banished from these societies.

China is loaded with mountains, but without our knowing their distinctive names. Father Verbiest tells us of one mountain which

he measured, and found to be a mile and half high: and we have reason to suppose that there are others still higher.

SECTION IV.

Mountains of Africa.

ATLAS, a chain of mountains extending from the Western or Atlantic Ocean to Egypt, is said to have received its name from a king of Mauritania (now the kingdoms of Fez and Morocco), who having been much attached to astronomy, used to make his observations on the heavenly bodies from the summit of the most western of these mountains, on which account the poets have represented him as bearing the heavens on his shoulders. The Atlantic Ocean is likewise said to have derived its name from this range of mountains. But many of the ancients fabled that Atlas was transformed into this mountain by Hercules, in consequence of the property possessed by the Medusean head of changing all who looked at it into stone: and that he was thus punished for having haughtily refused to entertain Perseus.

The remarkable chain of mountains which by some are placed between Algiers and Zahara, or the Desert, and by others within the dominions of Algiers, is considered as a continuation of Mount Atlas. These are not found to be so high as they were represented by the ancients; for Dr. Shaw observes that those parts which he saw are nearly equalled by some of the most lofty mountains in Wales; and he questions whether there are any that equal the Alps or the Appennines.

Among the mountains of BENI ABBESS, in Constantia, a province in the kingdom of Algiers, is a winding defile, which, for near half a mile, extends between precipices that rise to a great height on each side. At every winding, a rock, which originally went across it, and separated one valley from another, is cut in the form of a door-case, six or seven feet wide; and these are named by the Turks the Gates of Iron. Few persons can pass them without being impressed with horror; and a handful of men might defend the pass against a numerous army.

APES HILLS, or the MOUNTAINS of the APES, are situated on the north-eastern side of the peninsula of Africa, the shores of which form the southern boundary of the straits of Gibraltar; from the

town and fortress whence these straits derive their name, and which are seated on a mountain anciently called Calpe, these hills may be distinctly seen, being due south; the most conspicuous of them is called Abyla. Calpe and Abyla were by the ancients called The Pillars of Hercules: the distance between the two continents at these points is not more than twenty miles.

The MOUNTAINS of the MOON, called by the natives *Gebel el Kumr*, in the interior part of Africa, rising in the eastward of Nigritia, about the twentieth degree of longitude, and stretching into Ethiopia, although but little known, are supposed to be higher than those of Atlas. It is here the Nile is now known to have its source, in a district called Donga, lying in the eighth degree of north latitude.

The MOUNTAINS of SIERRA LEONA, or of the LIONS, divide Nigritia from Guinea and Benin; stretching from east to west, they enter Ethiopia about the tenth degree of latitude.

In EGYPT, to the south of Antinopolis, styled by the Arabs The City of the Magi, is a mountain called SHEBAT EL KOFFERI, on the side of which are some remarkable antiquities. After ascending the mountain for about two hours, the traveller arrives at a gate which leads into a great saloon, supported by hexagonal pillars cut out of the solid rock. The walls are adorned with paintings, which are still plainly to be distinguished, and the gold that was employed glitters on all sides.

MOUNTAINS OF ABYSSINIA. As this country lies in the torrid zone, the climate may be supposed to be very hot; but extreme heat is felt only in the champaign country, among the villages and low lands; for the tops of the mountains, most of which are of a great height, enjoy a delightful coolness. Hence this country is very healthful, but is subject to terrible storms of thunder and lightning.

Most of the mountains are said to exceed Olympus in height: yet these steep, and, to appearance, inaccessible rocks, are inhabited. They are surrounded with deep and extensive vallies, which, with the flat lands, are dry in winter, and commonly overflowed in summer by the rains, which instead of falling by drops, pours down with such vehemence, that the torrents from the mountains sweep away trees, houses, and sometimes rocks, while all the rivers, over-

flowing their banks, lay the country under water, which, on its retiring, leaves the land covered with a thick slime or mud.

Some of the mountains have large plains on their summits, covered with trees and other verdure, and afford excellent springs. Many of them abound in gold, as clearly appears from the dust found upon them, or washed down by the torrents, some pieces of that metal being of the size of a pea. But no mines of silver have yet been discovered.

Cape of Good Hope. On approaching the Cape of Good Hope, three remarkable mountains are visible at a considerable distance: these are the Table Hill, the Lion's Hill, and the Devil's Hill; they may be seen at sea as far off as forty or fifty miles.

Table Hill is the most lofty, and was thus named by the Portuguese, from its resembling at a distance a square table: the perpendicular height is upward of eighteen hundred and fifty feet, and yet on the top of it are several fine springs of clear and well-tasted water. In the summer season, which begins in September and continues to March, a cap of clouds constantly encompasses its summit before a storm, and thus gives the sailors notice to prepare for it. This appearance the people of the Cape call, The Devil's Table Cloth.

Lion's Hill lies contiguous to the sea, to the eastward of Table Mountain, from which it is separated by a narrow valley. According to some, it obtained its name from its resembling a lion *couchant*, with his head erect; according to others, from its having been infested with lions when the Dutch first settled in the country. On this hill is a flag guarded by soldiers, who give notice of the approach of ships, and shew their number, and from what quarter they come, by hoisting and lowering the flag.

Devil's Hill, supposed to be thus named from the furious storms that issue from it when the top is covered with a white cloud, is not so high as either of the former: it extends along the shore, and is only separated from Lion's Hill by a cleft, or small valley. These three hills lie in the form of a crescent about Table Valley.

Here is a very remarkable natural curiosity, near to Drakensteen, the third Dutch colony in this country, which is particularly described by Mr. Anderson, who was surgeon on board Captain Cook's ship, on his third voyage; it is a stone of remarkable size, called by

the inhabitants The Tower of Babylon, or The Pearl Diamond. It stands upon the top of some hills of no great height, is of an oblong shape, round on the top, and stretches nearly south and north. The east and west sides are steep, and almost perpendicular; the south end is likewise steep, and of the greatest height; whence it declines gently to the north part, by which Mr. Anderson ascended to the top, and had an extensive view of the whole country. Its circumference must be at least half a mile at its highest part: it seemed to equal in height the dome of St. Paul's church. It is one uninterrupted mass of stone, if we except some fissures, or rather impressions, not above three or four feet deep, and a vein which runs across near its north end: it consists chiefly of coarse quartz and glimmer, held together by a clayey cement. Sonnerat, who visited the Cape in 1781, gives a similar account of this extraordinary elevation. It is commonly supposed to be a volcanic production, though there is neither eruption nor crater at present.

The loftiest mountain appertaining to this quarter of the world is the PIKE OF TENERIF; but as this is evidently volcanic, we have already described it in a preceding chapter.

SECTION V.

Mountains of America.

NORTH AMERICA. This part of the continent, considering its very great extent, is far from being mountainous, and chiefly consists of gentle ascents and level plains; but it has a long range of mountains called APPALLACHIAN or ALLEGANY, which extend nearly from the Atlantic in one direction, to the river Mississippi in another, and the lakes northward. The late geographers of America describe these mountains as extending north-easterly and south-westwardly, nearly parallel with the sea-coast, to about nine hundred miles in length, and from sixty to two hundred in breadth. The various ridges which compose this immense range of mountains have now received particular names in different districts; that which passes by Pennsylvania, Virginia, and North Carolina, bears the name of the Blue-ridge, or South Mountains; they rise about four thousand feet in height from their base. Between this and what is called the North Mountain, an extensive and fertile vale is situated. What is properly called the Allegany, composes the principal chain, and has been

aptly styled "the back-bone of the United States." More to the southward is a long chain which bears the name of the LAUREL MOUNTAINS, from a sharp point of which, in latitude 36°, a spring of water issues, which runs through a channel fifty feet deep, is extremely cold, and as blue as indigo. The KITTANINY, or Blue Mountains, run along the northern parts of New Jersey and Pennsylvania; these have been called the Appallachian Mountains, from a tribe of Indians who live on the borders of a river which issues from this chain, and is called the Appallachikola. The mountains that constitute this interrupted chain are not, like those of Europe, confusedly scattered and broken, rising here and there into high peaks, over-topping each other, but stretch along in uniform ridges, scarcely half a mile high; though, as they proceed toward the south, some of them terminate in high perpendicular bluffs, whilst others gradually subside into a level country. Some of these mountains will admit of cultivation almost to their tops, whilst others are scarcely capable of cultivation, though many tracts of land which lie between the ridges consist of a rich black earth.

The most considerable in the state of New Hampshire are called the WHITE MOUNTAINS, from their appearing like snow; they being generally supposed to consist of a white flint, from which the reflection of the sun is very brilliant and dazzling. From their prodigious height they are to be seen at a very great distance. The basis of these mountains is a tract about fifty-five miles square, from which they rise in craggy heads one above another, in an irregular manner, all the way to the top. For the first four or five miles, beeches, hemlocks, and white pines grow; higher up, the growth is chiefly black spruce for six or seven miles, then the sides are cloathed with white moss; and still farther, all kinds of vegetation fail, which alone would render the ascent very difficult, but the mountain is likewise extremely steep.

Many streams of water gush out of the sides of these mountains, which run down with great rapidity. Indeed, the largest and best rivers in New England rise from different parts of them.

A late American geographer describes these mountains as extending north-east and south-west. Their height is reckoned, from observations made in the year 1784, to be five thousand five hundred feet above the level of the sea. The snow continues here nine or ten months of the year. From their summit, in clear weather, a

noble view, extending sixty or seventy miles, presents itself in every direction. The greatest height of these mountains is in latitude 44° north.

The volcanic mountains of Mexico have been already described, and need not be further adverted to.

WEST INDIES. The whole island of Jamaica is intersected by one continued ridge of hills, which runs from east to west through its middle, and is called the BLUE MOUNTAINS, on each side of which are chains of lesser mountains, which gradually sink as they approach the shore. The mountainous part is very steep, and the highest hills on their north and south sides are surrounded by very deep ravines made by the violent rains which almost every day fall on their summits, and first wearing a small channel for their passage, afterward carry every thing before them. Most of the savannas, or plains, cleared of wood and fit for pasture, lie near the south side of the island; they resemble our meadow land, and a person may ride several miles without meeting with the least ascent: some of the plains within the land are environed with hills. After rain they appear green and fertile, but after a long drought look yellow and parched.

In the island of Guadaloupe is the mountain LA SOUFRIERE, or the sulphur hill, which we have already spoken of under the head of volcanoes.

In the island of St. Christopher, on the top of the Conorrhee-hills, is a plain, not three hundred yards wide, ending at the edge of a cavity of a prodigious depth, and about a mile in circumference, containing sulphur, from which rise continual clouds of steam. A furlong to the south-east is a large rocky hill, called MOUNT MISERY, from a rash man, who, attempting to ascend the precipice, fell backward, and was killed. This is the highest point of land on St. Christopher's, and is said to rise about a mile and a half perpendicularly from the sea. In the sulphureous cavity above-mentioned are two or three round holes in the earth, vulgarly called the Devil's Coppers; they are two yards asunder, and each about three feet in diameter. Mr. Smith says, that when he saw them, they boiled fiercer than ever he saw a sugar-copper. On this hill there is a great quantity of pure brimstone, and on its top a powder-magazine.

SOUTH AMERICA. The mountains of this part of America form

one of the boldest features of the country. The chief of them are an immense congeries of mountains, called by the Spaniards CORDILLERAS (or chains) of the ANDES, stretching north and south from the isthmus of Darien through the whole continent of South America to the straits of Magellan, approaching the western coast, which is washed by the great Pacific Ocean, an extent of four thousand three hundred miles.

"Next to the extent of the New World," says Dr. Robertson, "the grandeur of the objects which it presents to view is most apt to strike the eye of an observer. Nature seems here to have carried on her operations upon a larger scale, and with a bolder hand, and to have distinguished the features of this country with a peculiar magnificence. The mountains of America are much superior in height to those of the other divisions of the globe. Even the plain of Quito, which may be considered as the base of the Andes, is elevated farther above the sea than the top of the Pyrenees. This stupendous ridge of the Andes, no less remarkable for extent than elevation, rises in different places more than one-third above the Pike of Teneriffe, the highest land in the ancient hemisphere. The Andes may literally be said to hide their heads in the clouds; the storms often roll, and the thunder bursts below their summits, which, though exposed to the rays of the sun in the centre of the torrid zone, are covered with everlasting snows."

Some of these mountains, which appear to have their bases resting on other mountains, rise to a most astonishing height, reaching far above the clouds. From experiments made with a barometer, on the mountain of COTOPAXI, it appeared that its summit is elevated six thousand two hundred and fifty-two yards above the surface of the sea, something more than three geographical miles, which greatly exceeds the height of any other mountain in the known world.

Cotopaxi became a volcano about the time when the Spaniards first arrived in this country; its eruptions are spoken of under the head of VOLCANOS.

A more clear idea of the nature of the climate on the top of these mountains cannot be conveyed than by describing what was observed on Pichincha, when Don George Juan and Don Anthonio de Ulloa were stationed there, in order, by accurate observations, to determine

the true figure of the earth. From this a judgment may be formed of the rest, the inclemency of the weather being in proportion to the height of the mountain.

PICHINCHA, though famous for its great height, is twelve hundred and seventy eight yards lower than the perpendicular height of Cotopaxi, and was formerly a volcano, but the mouth or crater on one of its sides is now covered with sand or calcined matter, so that at present neither smoke nor ashes issue from it. Our learned authors found the cold on the top of this mountain extremely intense, the wind violent, and they were frequently involved in so thick a fog, or, in other words, a cloud, that an object at six or eight paces distance was scarcely discernible. The air grew clear, by the clouds moving nearer to the earth, and on all sides surrounding the mountain to a vast distance, representing the sea, with the mountain standing like an island in the centre. When this happened, they heard the dreadful noise of the tempests that discharged themselves on Quito, and the neighbouring country. They saw the lightning issue from the clouds, and heard the thunder roll far beneath them. While the lower parts were involved in tempests of thunder and rain, they enjoyed a delightful serenity; the wind was abated, the sky clear, and the enlivening rays of the sun moderated the severity of the cold. But, when the clouds rose, their thickness rendered respiration difficult: snow and hail fell continually, and the wind returned with all its violence, so that it was impossible entirely to overcome the fear of being, together with their hut, blown down the precipice on whose edge it was built, or of being buried in it by the constant accumulations of ice and snow. Their fears were likewise increased by the fall of enormous fragments of rocks. Though the smallest crevice visible in their hut was stopped, the wind was so piercing that it penetrated through; and though the hut was small, crowded with inhabitants, and had several lamps constantly burning, the cold was so great, that each individual was obliged to have a chafing-dish of coals, and several men were constantly employed every morning in removing the snow which fell during the night. By the severities of such a climate, their feet were swelled, and so tender, that walking was attended with extreme pain, their hands covered with chilblains, and their lips so swelled and chopt that every motion in speaking brought blood.

"There is in all this range of mountains, as far as I have travelled," says M. Bouguer, who was engaged in the same expedition with the gentlemen just mentioned, "a certain boundary, beyond which the snow never melts; this boundary, in the midst of the torrid zone, I found to be two thousand four hundred and thirty-four fathoms above the level of the South Sea. The snow indeed falls much lower, but then it is liable to be melted the very same day; whereas above that it never melts, but serves to increase

"The gather'd winter of a thousand years."

A most extraordinary meteor, which the reader will find noticed in a subsequent chapter, is visible almost every day on the summit of these mountains, and has been so perhaps almost from the commencement of the world.

Though the severity of the air on these deserts is so great that all animals cannot live upon them, yet they afford subsistence for several varieties of deer, which feed on the straw or rushes peculiar to those parts; and some of them are to be met with on the highest mountains, where the cold is intolerable to the human species. Among the rushes are also bred great numbers of rabbits, and some foxes.

The only birds known in these inclement regions are partridges, which are something different from those of Europe, and nearly resemble the quail; also conders and hummers.

From most of these mountains flow rivers, over which, when too deep to be forded, bridges are made at the most frequented places. Of these there are two kinds, beside those of stone, which are very few. The most common are of wood, and the rest of bejucos, a plant peculiar to this country, and used for all the purposes of ropes. With regard to the first, they choose a place where the river is very narrow, and has on each side high rocks. These only consist of four long beams laid over the precipice, forming a path about a yard and a half in breadth, just sufficient for a man to pass over on horseback: and custom has made these so familiar, that the people pass them without any apprehensions.

The bridges of bejucos are only used where the breadth of the river will not admit of beams being laid across. In their construction several bejucos are twisted together, in order to form a large cable of the length required. Six of these are drawn from one side of the

river to the other, two of which are considerably higher than the rest, and serve for rails. Across the latter are wattled cross sticks of bejucos; and the whole resembles a fishing-net, or Indian hammock, stretched from one side of the river to the opposite. As the meshes of this net are very large, and the foot would be in danger of slipping through, they strew reeds at the bottom, which serve for a floor. "The reader will easily conceive," says M. Bouguer, "that the mere weight of this kind of basket-machine, and much more the weight of a man passing over, must cause it to make a prodigious bend; and if it be considered that the passenger, when he is in the midst of his course; especially if there be much wind, is exposed to wide swingings from side to side, to pass such a bridge, which is sometimes more than ninety feet long, it will be acknowledged to require great intrepidity of mind; yet the Indians pass over such bridges running, though loaded with the baggage and pack-saddles of the mules, and laugh at seeing the Europeans hesitate in venturing." Most of these bridges are only for men and women, the mules swimming over the rivers; for their loading being taken off, they are driven into the water near half a league above the bridge, that they may reach the opposite shore near it, they being carried so far by the rapidity of the stream.

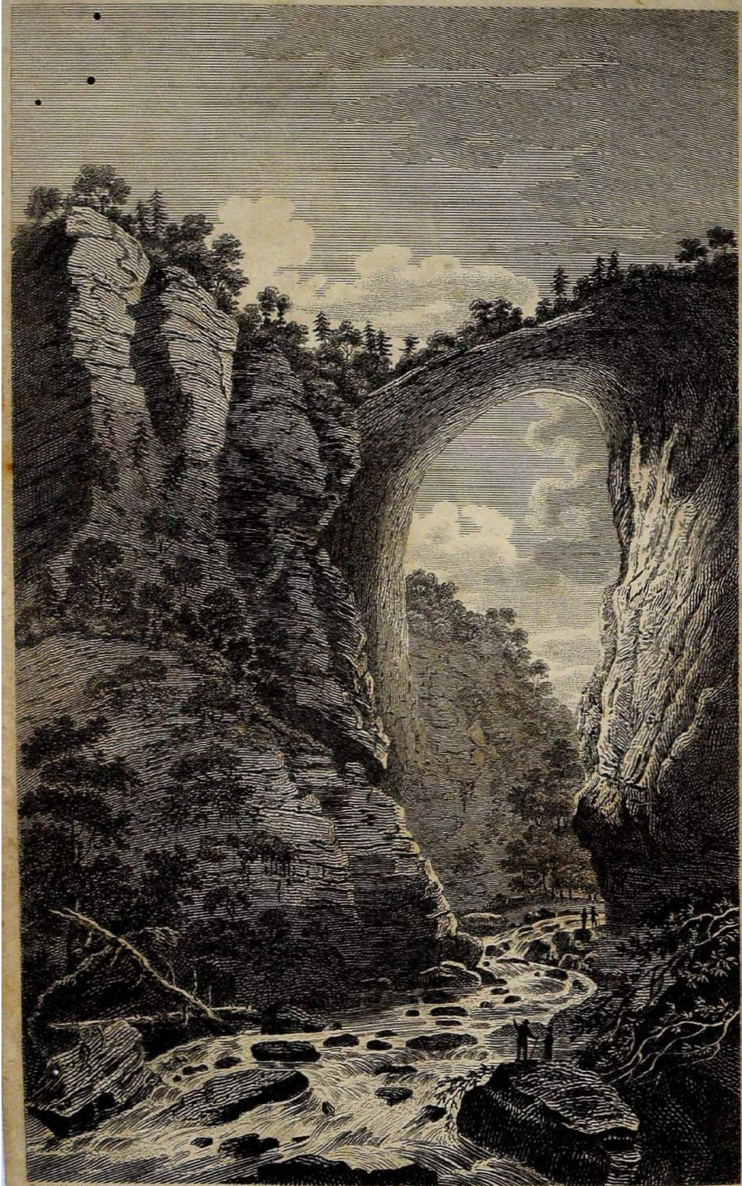
Some rivers, instead of a bejuco bridge, are passed by means of a *tarabita*, or single rope made of bejucos, or of thongs cut from the hide of an ox, and consisting of several thongs, about six or eight inches in thickness. This rope is extended from one side of the river to the other, and made firm on each bank to strong posts. On one side it is fastened to a wheel, that it may be straightened or slackened to the degree required. From the tarabita hangs a kind of leathern hammock, capable of holding a man, suspended by a clue at each end. A rope is also fastened and extended to the sides of the river, for drawing the hammock to the side intended, which a push, at its first setting off, sends quickly to the other side. This not only serves to carry over persons and loads, but also the beasts themselves, where the rapidity of the stream, and the prodigious stones continually hurried along by it, render it impracticable for them to swim across.

For transporting mules, two tarabitas are necessary, one for each side of the river, and the ropes are much thicker and slacker. On this rope is only one clue, which is of wood, and by this the

beast is suspended, he being secured with girts round the belly and neck. When this is performed, the creature is shoved off, and presently landed on the opposite side. Those that are accustomed to be conveyed over in this manner, never make the least motion, but even come of themselves to have the girts fastened round them; yet it is with great difficulty they are at first brought to suffer this to be done, and when they find themselves suspended, they kick and fling during their short passage.

The roads over some of these mountains are not the least of those extraordinary particulars relating to them. In many places they ar so narrow, that the mules have scarcely room to set their feet, anc in others they form a continued series of precipices. Beside which these roads are full of holes near three-quarters of a yard deep, ir which the mules put their fore and hind feet, so that sometime they draw their bellies, and the rider's legs, along the ground. Indeed, these holes serve as steps, without which the precipices woulc be impassable; but should the beast happen to put his foot betweer two of these holes, or not place it right, the rider falls, and, if or the side of the precipice, inevitably perishes.

The manner of descending seems still more dangerous. On one side are frequently steep eminences, and on the other frightful abysses and as they generally follow the direction of the mountain, the road instead of being on a level, forms abrupt precipices and declivities The mules are sensible of the caution requisite in these descents, for coming to the top of an eminence, they stoop, and having placec their fore-feet close together, draw the hinder feet a little forward as if going to lie down. Having in this attitude taken a survey o the road, they slide down with the swiftness of a meteor. The ride has nothing to do but to keep himself fast in the saddle, for the leas motion is sufficient to disorder the equilibrium of the mule, in whicl case they both unavoidably perish. The address of the beast is extremely wonderful; for in this rapid motion, when he seems to hav lost all government of himself, he follows exactly the different windings of the road, as if he had accurately settled in his mind the cours he was to follow, and taken every precaution for his safety. But the longest practice of travelling these roads cannot entirely free the mules from an apparent dread on their arriving on the top of a steep declivity; for they not only attentively view the road, but tremble and snort at the danger. If the rider inadvertently endeavour to



Engraved by Scott from a Drawing. — for the Gallery of Nature & Art.

ROCK BRIDGE IN VIRGINIA.

London: Published by R. Wilks, 89, Chancery Lane, May 1, 1813.

spur them on, they continue immoveable; and it is really wonderful to consider how, after having overcome the first emotions of their fear, they stretch out their fore-legs, that by preserving a proper equilibrium they may not fall, yet make with their body that gentle inclination necessary to follow the several windings of the road; and afterward their address in stopping themselves at the end of their impetuous career.

The height of the most elevated point in the Pyrenees is, according to M. Cassini, six thousand six hundred and forty-six feet. The height of the mountain Gemmi, in the canton of Berne, is ten thousand one hundred and ten feet. The height of the Pike of Teneriffe, according to the measurement of P. Treuillè, is thirteen thousand one hundred and seventy-eight feet. The height of Chimborazzo, the most elevated point of the Andes, is twenty thousand two hundred and eighty feet, no less than seven thousand one hundred and two feet above the highest mountain in the ancient continent. The line of congelation on Chimborazzo, or that part of the mountain which is covered perpetually with snow, is no less than two thousand four hundred feet from its summit.

In the federal state of Virginia we meet with a rock of a very singular character, and highly worthy of notice. It is thus described by Mr. Jefferson, the late President, in his "Notes on Virginia," with a slight correction of his measurements, for the sake of greater accuracy. He calls it *The Natural Bridge,* and then asserts as follows: "The Natural Bridge is the most sublime of Nature's works. It is on the ascent of a hill, which seems to have been cloven through its length by some great convulsion. Its height is 213 feet, its breadth at bottom about 50 feet, and at top about 90 feet; the passage over it is about 60 feet wide, and the thickness of the mass at the summit of the arch about 40 feet. A part of this thickness is constituted by a coat of earth, which gives growth to many large trees. The residue, with the hill on both sides, is solid rock of lime-stone. The arch approaches the semi-elliptical form, but the larger axis of the ellipsis, which would be the cord of the arch, is many times longer than its transverse. Though the sides of this Bridge are provided in some parts with a parapet of fixed rocks, yet few men have resolution to walk to them and look over into the abyss. You involuntarily fall on your hands, creep to the parapet; and peep over it. Looking down from this height

about a minute gave me a violent head-ache. If the view from the top be painful and intolerable, that from below is delightful in an equal extreme. It is impossible for the emotions arising from the sublime to be felt beyond what they are here: so beautiful an arch, so elevated, so light, and springing as it were up to heaven, the rapture of the spectator is really indescribable! This Bridge is in the county of Rockbridge, to which it has given name, and affords a public and commodious passage over a valley, which cannot be crossed elsewhere for a considerable distance." The view we have given of this singular rock was taken from the spot where it is usually and to most advantage beheld by its visitors, but the point of sight being so near an object so elevated, the receding lines of the perspective so rapidly decline, as to give an appearance of the ascent of the Bridge being reversed. It is further to be remarked that the stream, at the time of the drawing, had been swoln by preceding rains to a torrent, not always to be seen, and that there were two or three trees on the peninsula beneath the arch, which, as they obstructed the view of the back ground, were omitted.

[*Prevot. Gen. Hist. des Voyages. Don Juan Ulloa. Humboldt. Jefferson.*]

SECTION VI.

Mountains of Great Britain and Ireland.

THE British isles present many mountains of a bold and lofty character, but which nevertheless appear diminutive when contrasted with several of the different continents.

While Ben-Nevis, the highest mountain in Scotland, is not much above one quarter of the height of Mont Blanc, the sovereign of the Alps, the English and Welsh summits aspire to heights still less considerable; Snowdon being only 3568 English feet above the sea, while Ben-Nevis is 4387, or, by other accounts, 4350. But Wharn, or Wharnside, in Yorkshire, was estimated at 4050 *.

Even at the present day, the geography of some parts of New Holland is better understood than that of some parts of Great

* In the map of the West Riding, in Cary's English Atlas, Wharn is said to be 1780 yards, or 5340 feet: while Ingleborough is 1760 yards, or 5380 feet; and Pennigant 1740 yards, or 5220 feet. This measurement is from the map of Yorkshire, by Jeffries.

Britain. There is not even a separate map of the English rivers, though France set an example of this kind, a century and a half ago: nor has there been any attempt to delineate the chains of mountains in England. The imperfection of the materials must therefore apologize for any errors or defects in the subsequent slight sketch. The mountains of Cheviot may be said to form a regular ridge, running from the south-west, where they join those of Galloway to the north-east. But there is a central ridge which pervades England from north to south, beginning at Geltsdale fosest, 14 miles S. E. of Carlisle *, and passing on the west of Durham and Yorkshire, where it contains mines of coal and lead, but is split into insignificant appellations of *fells* and *laws*. Kelton-fell, Stanmore, Widehill-fell, Wild boar-fell, Bow-fell, Home-fell, Bun-hill, &c. &c. arise on the western limits of Yorkshire. Cumberland and Westmoreland present many detached mountains, Skiddaw, &c. which can hardly be reduced to any distinct arrangement; but those of Craven, in the West Riding of Yorkshire, as Wharn, or as commonly called by the country people, Wharnside, Ingleborough, and Pennigant; and Pendle on the east of Lancaster †; belong to the Central Chain, which proceeds south, through Derbyshire, still abounding with minerals and natural curiosities; but here it seems to terminate, spreading a little into Cheshire. Still, however, a central chain of smaller elevation, may be traced, in a zig-zag line, to near Salisbury, with two diverging and irregular branches on the east, one towards Norfolk, another into Kent, while a third runs south-west into Cornwall. To the first belong the hills of Gogmagog, in Cambridgeshire, &c. to the second the hills of Hampshire, Surrey and Kent. Malvern hills, in Worcestershire, deviate from the central ridge, while those of Cotswold, in Gloucestershire, may be regarded as a continuation of it. The hills of Mendip, Polden, Sedgemoor, Blackdown, in Somersetshire; the Tores and Wilds of Dartmoor, in Devon; and the hills and upland downs of Cornwall,

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* The heathy tract extends to Bewcastle and Nichol Forest, but is level. Housm. 427.

† That Ingleborow-hill, Pendle, and Pennigent,
Should named be the highest betwixt our Tweed and Trent.
Drayton's Poly-Olbion, Song 28.

It is remarkable that Wharn, the highest, is omitted.

extend this chain to the Land's End: and after passing this last rocky province, it expires in the Islands of Scilly *.

WALES is a country abundant in mountains, especially the northern provinces; but their orology remains indeterminate, and it would require the actual survey of an experienced engineer, to reduce them to chains and groupes. To begin with the north, Snowdon commands the first attention, a mountain of eminent height and fame. The top is called Y Widdfa, or The Conspicuous, forming almost a point, and presenting a view of the county of Chester, the mountains of Yorkshire, part of Scotland and Ireland, and the Isles of Man and Anglesey †.

Mr. Pennant does not specify the stone that composes it (probably a granite); but he observes that " large coarse crystals are often found in the fissures, and very frequently cubic pyritæ, the usual attendants on Alpine tracts." Mr. Aikin, in his last tour, brought specimens from the summit, consisting of schistose petrosilex mixed with a little steatite which supports argillaceous schistus. The petrosilex is in strata nearly vertical: the argillaceous schistus in beds nearly horizontal. From Snowdon, a line of mountains extends by the sea to Plenlimmon, a boundary of North Wales, whence issue the noble rivers Severn and Wye. Of these hills, Urrou Seth, Caer Idris, and Moyle Vadiau, are the most memorable. The hills on the east of North Wales, are far from attaining such considerable elevation, and gradully decline to the hills of Shropshire, of which the Wrekin is one of the most noted ‡.

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* Among the smaller elevations may be named the Chiltern-hills (whence the vague office of Steward of the Chiltern Hundreds) reaching from Tring in Hertfordshire, to Henley in Oxfordshire. In the latter county are Nettlebed and Shotover-hills.

† Pennant's Journey to London, p. 170.

‡ Mr Aikin, in his Tour in Wales, has considerably illustrated this subject. He observes (p. 19.), that the Ferwyn mountains occupy the east side of Merioneth, branching into Denbigh and Montgomery; length about sixteen miles, breadth from five to ten. Cader Idris is the second in height of the Welch mountains (about 3000 feet) and from it extends a primitive chain, running N. N. E. in the Arrans and Arranigs, consisting of porphyry and granitell. The second grand ridge, that of Snowdon, also runs N. N. E. and consists of schistose hornblende, micaceous schistus, granite, and porphyry, with some large blocks of serpentine; this chain extends from Penmaenmawr, towards Traethmawr: and after forming conic peaks at intervals, it ends in the northern horn of Cardigan-bay, that is the southern promontory of Caernarvonshire.

A chain proceeds due south to near Cardiff, in South Wales; it is of far inferior height, and a small branch diverges to the west, consisting of Cwn Cothy, Mynydd, Carregg, Brisley, and Cwm Kerrun-hills. On the east of South Wales, are the hills of Herefordshire, the Black Mountain, Cusop-hill, Hargest, Stokely-hill, &c.

Wales, as we have already observed, is singularly mountainous. The snow on many of its mountains lies for nine or ten months in the year. In Caernarvonshire the soil is particularly stony, and that county rises in vast mountains one above another, whence they have not been improperly called the English Alps. Snowden constitutes its highest hill, in the Welsh language Eryri, which signifies the Hill of Eagles. It is boggy on the top, and has two lakes that abound with fish, particularly the chor and the guiniard. The height of this mountain, reckoning from the quay at Caernarvon to the highest peak, Mr. Pennant says, is eleven hundred and eighty-nine yards and one foot. Snowdon was held as sacred by the ancient Britons as Parnassus was by the Greeks, and Ida by the Cretans. It is still said, that whoever sleeps upon Snowdon will wake inspired, as much as if he had taken a nap on the hill of Apollo. The Britons in very early times worshipped mountains and rivers. Mr. Pennant found pieces of lava on this mountain, and on the summit groups of columnar stones of vast size, lying in all directions. The sheep which feed on the sides of this mountain yield the sweetest mutton in Wales. Here are likewise many goats, which are driven to a considerable height, in the summer season, their keepers dwelling in tents, and subsisting on oatmeal cakes, butter, cheese, and whey.

The most remarkable mountain, next to that of Snowdon-hill, is Penman Mawr, which hangs perpendicularly over the sea at so vast a height, that few spectators would be able to look down the dreadful steep. On the side next the sea, is a road cut out of the rock, about six or seven feet wide, which winds up a steep ascent, and used to be defended on one side only by a steep wall, in some parts about a yard high, in others by only a bank, that scarce rose a foot above the road. The sea was seen dashing its waves forty fathoms below, with the mountain rising as much above the traveller's head. This dangerous road was a few years ago secured by a wall, breast-high, to the building of which the city of Dublin largely contributed, it being in the high road to Holyhead.

The vast hill of Plynlimmon, a part of which stands in Montgomeryshire, and a part in Cardiganshire, rises from a very extensive base, and towers to a great height. Its summit is boggy, presenting a most extensive view over a dreary and almost uninhabited country.

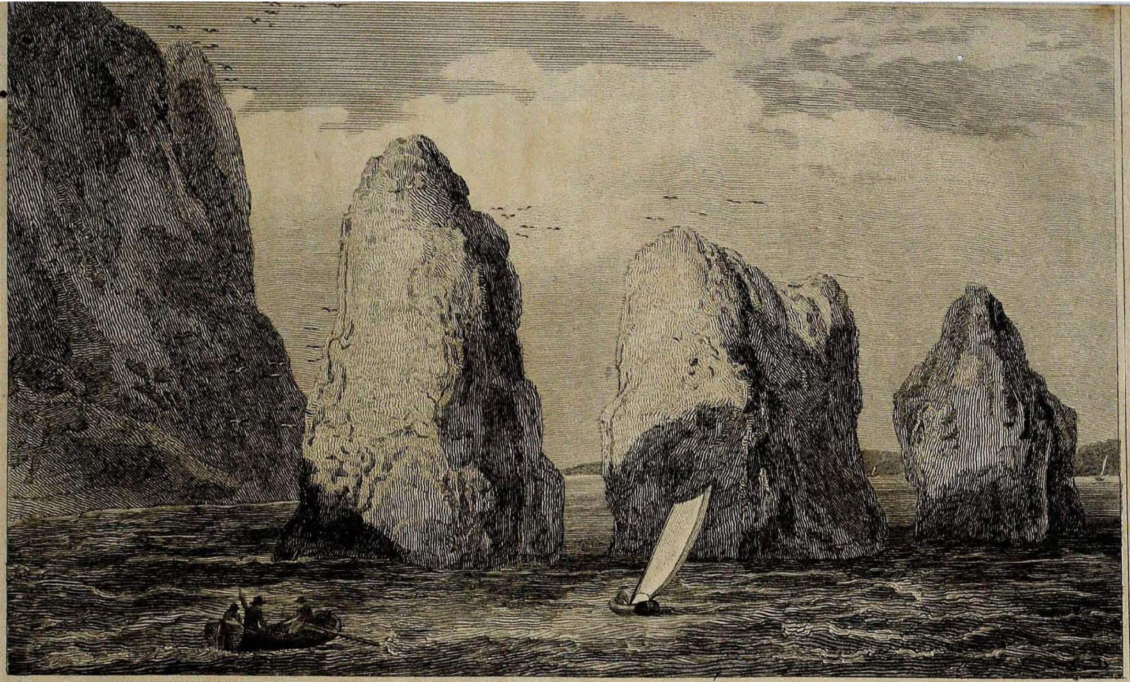
Among the many antiquities of Glamorganshire, one of the most singular is in the western peninsula of the county called Gower, where, on a mountain named Kevyn-Bryn, is a stone of an immense size, computed to weigh near twenty ton, laid upon several others by way of supporters. They are all of the mill-stone kind, and though the upper one is still so large, yet several tons have been broken off for mill-stones. It is commonly known by the name of Arthur's stone.

Mr. Housman has given a good general view of the ENGLISH MOUNTAINS. On coming from the south they begin in Derbyshire, stretching a little into Cheshire. The tops of the ridges are commonly wet and boggy, and produce heath, bent-grass, and rushes. They are almost universally calcareous. Near Penrith they almost wholly disappear. The summit of Crossfell is scarcely 1000 yards above the sea, and presents a large heap of loose whitish free-stone, or, more probably argillaceous grit.

The mountain of Skiddaw, in Cumberland, is one of the most remarkable in the kingdom, being above a thousand yards perpendicular height from the surface of Derwent-water. Here eagles and other birds of prey resort. This mountain is not difficult of access, and is covered with grass, which gradually grows coarser in the ascent. At the top the atmosphere is so rarefied as to prevent vegetation. The whole top is covered with a loose brown slaty stone.

Mr. Housman, in his Description of Cumberland, &c. (Carlisle, 1800, 8vo.) is the most recent authority for the height of the British mountains, which he exhibits in the following table: the measurement is from the level of the sea.

		Feet.
Snowdon, in Wales, by Waddington		3456
Wharnside	Do.	4050
Pendle hill	Do.	3411



Engraved by Berry, from a Drawing by Craig.

For the Gallery of Nature & Art.

THE NEEDLE ROCKS, ISLE OF WIGHT.

London, Published by R. Wilks, 89, Chancery Lane Nov. 15, 1813.

		Feet.
Pennygent, in Wales, by Waddington		3930
Ingleborough	Do.	3987
Helwellyn, by Donald		3324
Skiddaw	Do.	3270
Cross-fell	Do.	3390
Saddleback	Do.	3048
Benlomond		3240
Ben-Nevis		4350
Ben-y-bourd higher	By Pennant.	
Laghin-y-gair		
Benwewish	Perpetual snow.	
Skiddaw, by the experiments of Mr. Walker, from the plane of the sea, at Whitehaven		3530
Cross-fell, by Pennant		3839"

But great skill and precision are required in measuring the heights of mountains. A late excellent mathematician, Mr. Ewart, of Lancaster, measured the height of Ingleborough, with select and high-priced instruments, and great care. Here is the result, as communicated by Dr. Garnet:

Height of Ingleborough above the level of the sea, in feet and decimals.

By barometrical admeasurement	2377.12
By trigonometrical	2380.7
Difference only	2.67

Wharn cannot be above a hundred feet higher, while Pendle and Pennigent are lower. The measurements by Donald are probably near the truth; Crossfell being, in Dr. Garnett's opinion, the highest mountain in England.

A great part of SCOTLAND is mountainous, particularly toward the north and west. The principal mountains in this part of Great Britain are the Grampian-hills, which intersect the kingdom from north-east to south-west, passing from near Aberdeen into Argyleshire; the mountains in general are covered with heath, and are called the Highlands, but these in several places yield good pasture; between the higher grounds are many rich valleys, which produce corn and cattle. Indeed, the south parts of Scotland are far pre-

ferable to the northern parts of England. The grain mostly cultivated is oats, as it will grow in the mountainous parts. In unfavourable seasons, when the genial warmth of the summer sun has been sparingly imparted, much corn in the northern parts fails of ripining, and a scarcity of grain ensues.

The district of Roxburgh comprises many mountains, the most considerable of which is COCKRAW, whence run a chain of hills westward, dividing Scotland from England: these are in many places impassable; some of them are very high, but produce excellent grass, and abound with limestone and freestone.

The mountains of BRADALBANE are in the shire of Perth, and those of GRAINSTAIN bound Aberdeenshire to the south, in which latter country are the CRAIGS of PENNARE.

IRELAND is not a mountainous country, yet there are in different parts of the kingdom some mountains which rise to a considerable height. The GAULTEES are a chain of mountains in the county of Tipperary, which run in the direction of north and south, and tower majestically; MANGERTON, in the county of Kerry, is said to be three thousand and sixty feet in perpendicular height; the mountains of MOURNE and IVEAGH, in the county of Down, are also distinguished for their lofty summits. The base of Mourne terminates on the sea-shore, and in this chain SLIVE-DONAGH is three miles in gradual ascent, and half a mile in perpendicular height. These are reckoned among the highest mountains in Ireland, and are useful land-marks for sailors. They afford variety of plants, and many springs, while a multitude of cattle graze on them in summer. In one of them are quarries of mill-stone, and in another are found rock-crystals. They are also frequented by the infirm and debilitated in consequence of the invigorating power of their atmosphere, chiefly during the months of May and June. The nervous and scorbutic are said to find equal relief on these salubrious eminences; the latter, perhaps, chiefly from the medicinal plants which abound here, and the excellent whey produced by the goats, that equally embellish and enliven the general prospect.

According to Mr. Young, Mount Mangerton, on the south-west of Killarney, is 835 yards or 2505 feet above the level of the sea. There are other Irish mountains, however, that are still higher. The following we offer as a useful table, in which the estimate of the three first is from a geometrical measurement of Colonel Her-

bert, and the three last from a barometerical measurement of Mr. Kirwan.

Slieb-Donard, co. Down . . .	2803 feet
Mangerton, co. Kerry	2511 feet above the sea
Ditto	823 feet above the Lake of Killarney
M'Gillicuddy's Reeks	2800 feet
Croagh Patrick, co. Mayo . . .	2660 feet
Napkin, co. Mayo	2634 feet.

[*Pennant. Housman. Aikin.*]

SECTION VII.

EXTRAORDINARY OR PICTURESQUE PRECIPICES AND PROMONTORIES.

Bessely Gaut, in the Territory of Mysore.

WE have already observed that the Indian Appennines, which stretch along the Western or Malabar coasts in the Peninsula, and the precipitous path-ways which they occasionally disclose, are called Gauts*. Of these abrupt and perpendicular precipices, Bessely Gaut is one of the most romantic; and we have rather chosen to give it a particular place here than to describe it in the general Account of the Mountains of Asia. We shall take our description from Lord Valentia.

"As we advanced, the scenery became more wild, and the road so uneven, that though the bearers were excellent, they were frequently obliged to rest themselves, for we were now entering the defiles of the chain of mountains, that separates the table land of Mysore from the low country of Canara and Malabar, It was two o'clock in the morning when we reached Purneah Chuttoor, a distance of twenty miles. This place is at the summit of the Bessely Gaut, the most sourthern of the whole.

"March 7.—At three in the morning I began to descend this celebrated Gaut. The road has been formed with great labour out of a bed of loose rock, over which the torrents in winter had run with such force as to wash away all the softer parts, and in several places to leave single rocks, of four or five feet diameter, standing in the centre of the road, not above two feet asunder. To get the palanquin over these was a tedious and difficult business; however it escaped uninjured. The boys were obliged to use sticks with iron

* See Section iv. of the present Chapter.

spikes at the end, to prevent themselves from being thrown forward by the weight of the palanquin, though I walked the whole way, not only to relieve them, but to admire the sublimity of the scene. We had entered a forest of the largest trees of the East, several of which were one hundred feet in the stem before a single branch extended; yet the descent was so steep, that I was frequently on a level with their tops at so small a distance, as to be able to distinguish them by the gleam of the numerous torches which accompanied me, but which were insufficient to enlighten the impenetrable canopy of foliage that for miles concealed the face of heaven, or the deep gloom of the abyss into which we seemed to be descending. In the day time the scene could not have been half so awful or magnificent. Purneah had continued his attentions to us, by an endeavour to repair the worst part of the road; had nothing been done, I know not how we should have ever passed it. General Wellesley made the road perfectly good; but the descent was so steep, and the torrents so violent, that one rainy season reduced it to the state in which I found it. Our descent was impeded by meeting with numerous droves of oxen which were ascending the Gaut loaded with salt, having carried down grain to Mangalore.—Towards day I came to a turn in the road, where an opening showed me the lofty mountain I had been descending, covered with forests to nearly its summit. We had passed several rivulets; here they had joined and formed a small stream. On Mr. Salt's joining me at Mangalore, who for want of bearers had been obliged to keep one stage in the rear, I was happy to find that this scene had so struck him from its magnificence, that he had taken a drawing of it.

"I was now able to perceive the rich vegetation around me, and which immediately struck me with surprise, from its resemblance to that of Ceylon. The branches of the loftiest trees were covered by the parasitical tribe; the Epidendrons and Filices were various and beautiful; but the most conspicuous was the Draçontium pertusum, which perfectly covered the gigantic stem of the Ficus bengalensis with its leaves. The Laurus cassia was amongst the underwood; and the side of the road was beautified by several species of Justicia. I frequently stopped to wander a little from the road to collect seeds, in which I was very successful. I passed a small village in the centre of this immense forest, where the inhabitants were threshing their grain in a truly patriarchal manner; on a floor of

hard earth the grain was trodden by oxen, which, according to the Mosaical law, were left unmuzzled.

[*Lord Valentia's Travels.*]

2. *Passage of Taranta, in Arabia Felix.*

The whole of this mountain was thickly set with kolquall, which grows nearly to the height of forty feet; towards the top the berry-bearing cedar of Bruce, (called by our guide Cereder) began to make its appearance, and became more abundant in proportion as we ascended; the summit of the mountain being covered with a thick copse of this tree. In the most rugged path of the road we dismounted, to ease our mules, and walked for about half a mile; we then remounted, and gained the top without any further difficulty. As soon as we arrived we found, on looking at our watches, that it was only half past two; so, notwithstanding all our delays, we had been occupied only three hours in overcoming the exaggerated perils and toils of the passage of Taranta. We now directed our course into a beautiful little green valley shaded by cedars, and adorned by a pool of water; the sight of which was particularly grateful to us, as we had been repeatedly told that there was none on the top; near it was grazing a large herd of cattle.—Wandering about the valley we discovered a great profusion of mushrooms, of which, notwithstanding they were considered by the natives as poisonous, we collected a large quantity; part we stewed for immediate use, and the remainder we bottled, and found them both wholesome and highly grateful, in the total want of vegetables which we afterwards experienced. Soon afterwards, Captain Rudland shot an owl of a very large species, and Mr. Carter and myself collected a number of flowers, several of which had bulbous roots; among the shrubs were the sweet-briar, and several others highly aromatic. We were soon overtaken by the men and boys who had charge of our baggage; one of our heaviest boxes, containing ammunition and dollars, of considerable weight, was, to our surprize, brought up by a boy about thirteen years of age; and one of the walls of our large tent, together with the two poles, were conveyed by one man from the bottom to the top of the pass in about four hours. It is not easy to reconcile these facts with Bruce's representation of the extraordinary difficulties with which he had to contend during two days in going over the same distance, unless the re-

establishment of peace between the Nayib, and the tribe of Hazorta, had been attended by a surprizing improvement of the road, which is not probable, as by Bruce's own account the trade, if we may judge by the number of slaves, was then fully equal to what it is at present. Besides, we did not meet with a single hyæna or troglodytical cave; and luckily "had not our hands and knees cut by frequent falls, or our faces torn by thorny bushes;" which last, indeed, appears scarcely possible in so open and frequented a path. The only part of our baggage that did not reach us till late at night, was the fly of the tent, and my bed, which were carried on the back of an ox; in consequence of which, the evening being very cold, we arranged our baggage in a half circle, made a good fire in the centre, and slept on the walls of the tent, having previously regaled ourselves with salt fish, rice, and stewed mushrooms.

"July 27.—A shower fell in the course of the night, and when we awoke, the sky was so lowering, that, though our guide declared it was only the common morning mist, we thought it prudent to pitch our tent, under which we obtained shelter from a smart shower of rain which fell soon after. The tops of Taranta, surrounding the little valley in which we slept, had hitherto been obscured by fleeting clouds; at seven they began to clear away, upon which we dispatched the baggage forward, and about eight o'clock set out ourselves. We had not however ascended the first rising ground before heavy rain came on, and continued, with very short intermission, during the whole of the day. Thence the descent became very rapid, and the road lay through gullies, down which the waters were beginning to run with great force; but none of these obstacles seemed to delay our mules: they descended almost like goats from rock to rock, and not one of the whole number made a single false step in the course of the day. Notwithstanding our cloth-coats and camolines, we were all wet to the skin, and, on account of the difficulties of the road, were not able long to keep together; so that, while Captain Rudland and myself were proceeding on the direct road, Mr. Carter and Pearce were wandering wherever the mules chose to carry them, and, as it afterwards appeared, they had actually arrived within half a mile of Dixan, when they turned, and made a circuit of about five miles.

[*Lord Valentia's Travels.*]

Genátur, the Capital of Agowma, in Abyssinia.

"ALMOST the whole of this part of the country consists of rocky hills and cultivated valleys, through which our road wound in a general direction from south-east to south-west. About six miles from Calaut, we passed Gullimuckida and Ersubhah on our right hand. We had scarcely gone two miles farther, when we were overtaken by the young warrior Aggoos, attended by two of his fighting men on horseback. He stopped to speak to Hadjee Hamed; but his impatient spirit could not brook travelling at the slow rate we were going: accordingly, in a few minutes, he galloped away, and we soon lost sight of him behind the hills in our front. A messenger on horseback soon after met us to gain intelligence of our approach, and with him our friend Negada Moosa rode forward to get all things in readiness for our reception. The country was very rich in pasturage, and we saw vast herds of cattle feeding in the different valleys, also a few horses, of a small breed, but which were however capable of much work. We alarmed two jackalls on the plain grubbing up roots, but they fled so swiftly up the hills that Captain Rudland could not approach within gun-shot of them. About three o'clock we arrived at Genátur, the capital of the district of Agowma. It is a village, consisting chiefly of conical huts, overlooked by a high rock, steep on every side, and on the top of which is an area about one hundred feet in diameter, occupied partially by a citadel. Here we were met by Subagadis, the elder of the four sons of Shum Woldo. He uncovered himself with great humility on approaching, and saluted us by kissing our hands; he then led us into his state room, which was not unlike a hall in some of our old English mansions, being lofty, and supported by round posts in the centre. Here he treated us with an excellent fowl-curry, wheaten loaves cooked in steam, and plenty of maise; he also presented me with three bullocks, four pots and two skins of honey; as he expressed it, by the Ras's order. All this time his brother Aggoos had been standing behind him, not being allowed, as it should seem, to sit in his presence. We spent this day very pleasantly, being treated with great hospitality by the master of the mansion, who was in his manners by far the most polished Abyssinian we had yet seen. He had a mild ex-

pression in his countenance, his features were regular, his hair was short and curly, but not woolly, and his limbs, though small, were well-formed. The thermometer was 66°.

[*Lord Valentia's Travels.*]

3. *Promontory of Parthenium, in the Crimea.*

FROM the little harbour lying between the cities of Chersonesus and Eupatorium, an artificial canal, winding round towards the walls of the former, and hewn in the rock, yet remains very entire. It was calculated to admit small vessels within the suburbs of the city. Towards the extremity it is now dry, although the fishing-boats of the inhabitants still enter its mouth. "In this city," says Strabo*, is the temple of a virgin, a certain dæmon, from whom also the promontory is named, an hundred stadia farther on, and called Parthenium; having the fane of the demon, and her image. Between the city and the promontory are three ports." Taking therefore this clue, and following the coast, the three harbours mentioned by Strabo will be found to occur very regularly; but it is not so easy to determine the particular promontory on which the shrine and statue of the dæmon virgin was said to stand. As the coast inclines towards the South, a very remarkable black rock advances from the cliff into the sea, towards the West, perforated by a lofty natural arch, through which boats may pass. The singular appearance of such a scene might furnish a basis for superstition; and above this rock were the remains of a building of an oblong form, constructed with very considerable masses of stone placed together without cement. Near, were also other ruins. Farther on is a promontory still more striking, to which Formaleoni † gives the name of "The Promontory of Parthenium;" terminated by a perpendicular precipice of very great height. Then follows the bay in which stands the Monastery of St. George, in a picturesque and singular situation, so placed among sloping rocks as to seem inaccessible. The few monks who reside there have formed their little gardens upon terraces one above another. If there be any thing which can strengthen Formaleoni's opinion, it is the circumstance of the foundation of a monastery and chapel so near the spot. The early Christians, on

* Strab. Geog. lib. vii. p. 446. ed. Oxon.

† Hist. Philos. et Polit. du Comm, &c. dans la Mer Noire. Ven. 8vo. 1789.

the destruction of Pagan edifices, almost always erected new buildings, sacred to their own religion, upon the spot, and often with the materials, of the old. The monks of the monastery, in the ground behind their chapel, had recently found a small stone column, the shaft of which was seven feet eight inches and a half in length, and thirteen inches in diameter. This column, together with a few broken slabs of marble, and other antiquities discovered there, seem to prove, supposing Formaleoni's position of Parthenium to be correct, that in this situation stood the *old* Chersonesus, which Strabo, after speaking of the *new*, describes as in ruins, and as occurring after the promontory *. That there is some reason, however, to dissent from the opinion maintained by Formaleoni, will appear in the sequel; as there is a promontory between the monastery of St. George and the harbour of Balaclava, which, independent of the tradition concerning it, is perhaps more suited to the account Strabo has given of the fane of the dæmon virgin, as well as to the terrible nature of her rites †.

[*Clarke's Travels.*]

4. *Harbour of Balaclava, near Parthenium.*

AFTERWARDS we set out again, by the common road, to Balaclava, with a view to examine that place, and then to traverse the

* Μεταξὺ δὲ τῆς πόλεως καὶ τῆς ἄκτρας, λιμένες τρεῖς· εἶθ' ἡ παλαιὰ Χεῤῥόνησος κατεσκαμμένη.

"Inter urbem et promontorium portus sunt tres; sequitur vetusta Cherronesus, diruta." [Strab. lib. vii. p, 446. ed Oxon.]

† "On that inhospitable shore," says Gibbon, speaking of the Taurica Chersonesus, "Euripides, embellishing with exquisite art the tales of antiquity, has placed the scene of one of his most affecting tragedies. [Iphigen. in Taur.] The bloody sacrifices of Diana, the arrival of Orestes and Pylades, and the triumph of virtue and religion over savage fierceness, serve to represent an historical truth, that the Tauri, the original inhabitants of the peninsula, were in some degree reclaimed from their brutal manners, by a gradual intercourse with the Grecian colonies, which settled along the maritime coast." This seems to concede more to allegory, than is consistent with the antient history of the Greek Drama; in which so much attention was paid to the strict tenor either of record or tradition. It is uncertain to which of the heathen Goddesses the dæmon virgin of Strabo may be referred. The Editor of the Oxford Strabo (p. 446, in Not.) suspects that she was of Scythian origin. Her image was believed to have fallen from heaven. Orestes carried it into Greece; but the base of the statue, according to Ovid, remained. In the language of the Tauri, her earliest votaries, she was called Orsiloche. Ovid calls her Orestea Dea. [Epist. 1. Ex Pont. lib. i.]

whole coast as far as Alusta; which journey would comprehend not only the finest scenery of the Crimea, but also would complete our survey of its southern coast. So much has been said by travellers of the famous valley of Baidar, that the vale of Balaclava, which is hardly surpassed by any prospect in the Crimea, has hitherto escaped notice. Yet the wild gigantic landscape, which towards its southern extremity surrounds the town; its mountains; its ruins, and its harbour—the houses covered by vines and flowers, and overshadowed by the thick foliage of mulberry and walnut-trees; make it altogether enchanting. The ruins at Balaclava point out the ΠΑΛΑΚΙΟΝ of Strabo; whence some believe it derived its present name.

Others, and perhaps with more reason, suppose the name to have had a Genoese origin; and derive it from Bella Clava, the beautiful port. Its harbour is certainly the ΣΥΜΒΟΛΩΝ ΛΙΜΗΝ, *Portus Symbolorum*, the characteristic entrance to which Strabo so accurately describes *. Nothing can equal the fidelity with which he has laid down the coasts of the Crimea; a circumstance which may perhaps be attributed to the place of his nativity, Amasia, whose situation enabled him to acquire familiar knowledge of the shores of the Euxine. In his account of the Archipelago and Mediterranean, although always an accurate writer, he by no means evinces the same degree of precision. According to him, the port of Balaclava, together with the Ctenus, or harbour of Inkerman, constituted by their approach an isthmus of forty stadia, or five miles; which, with a wall, fenced in the minor peninsula, having within it the city of Chersonesus †. The wall we found afterwards with Professor Pallas, and its extent agreed very well with Strabo's account.

The port of Balaclava is certainly one of the most remarkable in the Crimea. From the town it appears like one of the smallest of our northern lakes, land-locked by high precipitous mountains. Though its entrance is so narrow that ships can hardly find a passage, yet it affords excellent anchorage and security in all weather from the dreadful storms of the Black sea. Ships of war, of any burden, may find sufficient depth of water, and a safe asylum there. The heights around it are the first objects descried by vessels in sailing

* Καὶ μετ' αὐτὴν, λιμὴν στενόστομος. Et post hanc portus angusto introitu. [Strab. lib. p. 446. ed. Oxon.]

† Strab. lib. vii. p. 446. ed. Oxon.

from Constantinople. But if any ill-fated mariner, driven by tempests, sought a shelter in the port of Balaclava, during the reign of Paul, he was speedily driven out again, or sunk, by an enemy as inhospitable as the wind or the waves. The inhabitants had small pieces of artillery stationed on the heights, with the most positive orders, from that insane tyrant, to fire at any vessel who should presume to take refuge there. The town is at present colonized by Greeks from the Morea: a set of daring pirates, to whom the place was assigned by the late Empress, for the services they rendered in her last war with the Turks. We found the inhabitants of Misitra, Corinth, of the Isles of Cephalonia, Zante, &c., living without any intermixture of Tartars or Russians, according to the manners and customs of their own country. We were treated by them, as I had reason to think we should be, with every degree of politeness and hospitality. The paroxisms of the fever I had caught in the bad air of Inkerman, perhaps increased by constant fatigue of mind and body, might have induced many a worthy landlord to have denied me admission to his house, through fear of communicating the plague to his family; but the brave Spartan Feodosia*, with whom we lodged at Balaclava, not only received me, but attended me with all the solicitude of a Samaritan. We arrived by moonlight: his house was beautifully situated upon a rock near the harbour. The variety of different nations which are found in the Crimea, each living as if in a country of its own, practising its peculiar customs, and preserving its religious rites, is one of the circumstances which renders the peninsula interesting to a stranger. At Baktcheserai, Tartars and Turks; upon the rocks above them, a colony of Karaïte Jews; at Balaclava, a horde of Greeks; an army of Russians at Akmetchet; in other towns, Anatolians and Armenians; in the *steppes*, Nagays, Gipsies, and Calmucks; so that in a very small district of territory, as in a menagerie, very opposite specimens of living curiosities are singularly contrasted. Nor is it only with a view to its natural history that the traveller finds ample source of instruction; his attention is continually diverted from such considerations by the antiquities of the country. At Balaclava they offered for sale several Greek coins of uncommon beauty and rarity; the most

* A corrupt mode of pronouncing Theodosia; as Theodore is often pronounced Feodore; and Theodoric, Feodoric; Federick, and Frederick; thus we have the singular derivation of Frederic from Theodore.

remarkable were of silver. I shall only mention those at the foot of the page, which, if not unique, are the least known*.

On the heights above the mouth of the port, are the ruins of a magnificent fortress, built by the Genoese when they possessed this harbour. The arms of Genoa are upon the walls. The mountain on the north-east side is covered by its mouldering towers, and the rock itself has been excavated so as to exhibit stately magazines and chambers, the sides of which were lined with coloured stucco. It is surprizing the inhabitants of Balaclava do not use these caves; for they are very habitable, and the stucco is still in the highest preservation. We entered one, which was a spacious oblong chamber lined throughout with stucco, and somewhat resembling the famous *Piscina mirabile*, near the supposed villa of Lucullus, at Baia, in Italy. We could form no conjecture for what purpose this place was intended, except as a granary or store-room; it bore no marks of any aqueous deposit upon its sides, and was at the same time dry and in perfect preservation; therefore it could not have served as a reservoir for water. The mountains, which surround the port, are of red and white marble, full of cracks and fissures; but calculated for ample quarries, if worked beyond the surface. The shore is in some parts covered by a fine glittering sand, the particles of which consist wholly of gold-coloured mica, in a state of extreme division; making the most beautiful writing sand that can be used; and, as it may be obtained in any quantity, would answer very well as an article of commerce. There has been nothing of the kind yet sold by stationers which can be compared with the sand of Balaclava; for, when scattered over fresh writing, it produces an effect as if the

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* They were as follow: A silver medal of Heraclea, *Præcipui Nitoris*, to use the express words of Pliny concerning the city to which it belonged. Heraclea was, according to that author, the name of the Chersonesian city; and this medal exhibits on one side a bearded head of Hercules, covered by the lion's skin, and on the other, within an indented square, the word ΗΡΑΚΛΕΙΑ, with the letters ΔΑΜ. A second of Phocis, of similar size and workmanship, having on one side a bull's face, and for reverse the head of Apollo, with the letters ΦΟΚΙ. A third in silver, and of the same size, I believe, of Elis. It has on one side an eagle's head, and for reverse a thunderbolt. The fourth is of still smaller size, and of the same metal; to me unknown. It has on one side a scorpion, and on the other, within an indented square, a dolphin. The fifth, and last which I shall notice here, was a bronze medal of Rhæmetalces, king of Bosporus, having in front the regalia sent from Rome for his coronation, with the legend ΒΑΣΙΛΕΩΣ ΡΟΙΜΗΤΑΛΚΟΥ, and for reverse the letters ΜΗ in a wreath of laurel.

ink had been covered with minute scales of polished gold, which it will retain for any number of years.

The appearance of so much mica might induce an opinion, that a foundation of rocks of a formation anterior to those which surround the port, cannot be very remote; but there is no part of the world where geological phænomena are so extraordinary. Pallas often confessed, that in all his travels he had never met with similar appearances*. It is impossible to conjecture the depth at which the primitive foundation of granite lies; there are no traces of any such substance; not even among the pebbles on the coast. The strata of the Crimea have been formed by a process so inexplicable, that no attention to their position will afford matter for any regular systematic arrangement. Advancing from the isthmus of Perecop, towards the chain of mountains which line all the southern coast, the great northern plain of the peninsula, consisting of a soft calcareous deposit, by an alternate series of depressed surfaces, continually sinks towards the south. Almost all the principal elevations of the globe rise from the east, and fall towards the west. The declivities of the Crimea, and the precipitous sides of its mountains, are all opposed to the south. Perhaps a familiar exposition of these geological features may be afforded, by saying, that the perceptible elevations of

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* The small tract which he published at Petersburg in 1796, and which he extracted from the Journal of his Travels in the Crimea, in 1794, has been before noticed. It is so extremely rare, that the reader will perhaps be gratified by the insertion of a short extract concerning the singular phænomena displayed in the geology of the peninsula. "Dans un pays qui a des montagnes si élevées, que quelque part la neige et la glace s'y conservent pendant tout l'été, qui d'ailleurs est isolé par la mer, on devroit, selon les loix générales de la nature, s'attendre à trouver *les trois ordres* de montagnes: les *primitives* granitiques pour centre d'élévation; les schisteuses *secondaires*; et les *tertiaires* à couches horizontales, melées de petrifactions; ou bien, comme en Sicile, un noyau ou *centre volcanique* et les couches sécondaires et tertiaires sur les contours. Mais en Tauride il n'existe ni l'un ni l'autre de ces arrangements observés dans tous les autres pays de montagne. L'on ne voit, dans l'escarpement maritime de toute la haute chaine des Alpes de la Tauride rien que des couches sécondaires du dernier ordre, inclinées sur l'horizon à un angle plus ou moins approchant celui de 45 dégrês et presque toutes plus où moins parallèles posées dans une direction qui varie entre le sud-ouest et le nord-ouest. Toutes ces couches sont donc coupée par la direction de la côte, et on le voit toutes à découvert sur l'escarpement maritime des montagnes, *comme les feuillets d'un livre ou les tomes d'une bibliothèque.*" *Tab. de la Taur*, *pp.* 3, 4, 5.

the peninsula, visible even in its plains, resemble, by their alternate order, the teeth of a saw.

Towards the south, its highest mountains are all broken off abruptly, as if by the sinking of the main bed in the depths of the Black Sea. Towards the north, a tertiary deposit of calcareous matter, filled with the remains of shells, extends beyond the isthmus, even to the Dnieper. Thus the exterior, or upper strata, of the peninsula, consist of calcareous matter, of very recent formation, in which there is nothing otherwise remarkable, than the proof they afford by the remains of marine bodies of the draining of the waters from the great Plain of Tartary; a subject we shall not now further discuss. But the wonder is, that where mountains have attained an elevation of above twelve hundred feet, no trace, either of primitive granite, or, as a leader to it, of any regular schistose deposit should appear. Beneath these enormous calcareous masses, pillars, if they may be so called, of marble, trap, clay, common limestone, and schistus, make their appearance in parallel and almost vertical veins, propping up the superincumbent strata. Pallas forcibly illustrates their position by observing, that they stand like books upon the shelf of a library *. These veins alternate with each other; and although they are somewhat inclined, leaning from north-west towards the south-east, yet their position in certain instances is nearly vertical. These extraordinary phenomena may be discerned all along the south-western coast; and that the depth to which they extend is very great, will be evident from the representation of the marble mountains of Balaclava, whose precipitous elevation from the sea, bespeaks a corresponding depth below the water †. When the veins of clay are washed away by the sea, either vast chasms are left, or the neighbouring veins fall in; as it happened upon the south coast at Kutchuckoy, not long ago, when a whole village was buried, which the late empress rebuilt at her own expence. In the clay is sometimes veined slate, and often blocks of wood, so impregnated with bitumen, that it burns like coal. The coast of Balaclava is entirely of marble; more towards the north-west, as at the monastery of St. George, it consists of black

* See the note, p. 457.

† The engraving made from Mr. Heber's very faithful drawing also shews the manner in which the veins of marble, trap, clay, &c. are inclined towards the horizon.

slate: further on, the other substances occur, in the order and position already described. To the north of the coast these veins are covered by calcareous matter, extremely full of the remains of organized bodies. The extraneous fossils of the Crimea are very curious; many of them relate to animals now unknown. Of these may be mentioned the *lapis nummularius*, which is very common here, and rare every where else. It is found about the Pyramids of Egypt, and in some parts of France *.

5. *Cape of the Winds, in the Crimea.*

The fortress of Mankoop is of very extraordinary magnitude, and may be described as literally in the clouds. It covers the summit of a semicircular insulated mountain; this, from its frightful aspect, its altitude, and craggy perpendicular sides, independent of every other consideration than as a surprising work of nature, fills the mind with wonder upon entering the defile. In that singular situation, where there were no visible means of ascent towards any of the heights, much less of conveying materials for the astonishing work they completed, did the Genoese construct a citadel, perhaps without a parallel in Europe, the result of their wealth, address, and enterprise. History does not mention for what especial purpose those works were carried on by the Greeks or Genoese in the interior of the country, at such a distance from the coast; but it is natural to conjecture their use in curbing the hostile spirit of the natives towards the maritime colonial possessions. The last pos-

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* Strabo noticed this fossil at the Pyramids of Egypt, and we afterwards found it there exactly as by him described. He supposed it to have been formed of the lentils petrified, which were given as food to the workmen employed in building the pyramids. Pallas has attempted to account for its origin by an opinion which is entirely his own. "I cannot on this occasion omit to express my opinion respecting a fossil, the origin of which has not hitherto been explored. As its external shells have no orifice whatever, and may easily be separated from each other, while its internal cellular texture, consisting of annular divisions, and thin lateral scales, has not the least resemblance to the abode of a testaceous animal, but rather to the inner structure of a cuttle fish-bone; I am induced to conjecture that the lenticular stones have originated in the shell or bone of a peculiar gregarious species of doris, or sepia, which formerly inhabited the deep, has in process of time been mixed with the calcareous mire deposited by the sea, and thus at length become completely extinct; so that we possess no account of its living state. *Travels*, vol. ii. p. 21.

sessors of Mankoop were Jews. Ruined tombs of marble and stone were lying in the cemetery of their colony beneath the trees we passed in our ascent. The whole of our passage up the mountain was steep and difficult; nor was it rendered more practicable by the amazing labours of its original possessors, whose dilapidated works rather served to impede than to facilitate our progress. The ascent had once been paved the whole way, and stairs formed, like those of the Merdveen; these still remain entire in many places.

When we reached the summit, we found it entirely covered with ruins of the citadel. Caverns and gloomy galleries perforated in the rock, whose original uses are now unknown, presented on every side their dark mouths. On the most elevated part of this extraordinary eminence, is a beautiful plain, covered with fine turf, among which we found the rosa pygmæa of Pallas, blooming in great beauty. This plain, partly fenced in by the mouldering wall of the fortress, but otherwise open to surrounding precipices, appeared to me as lofty as the cliffs along the Sussex Coast, near Beachy Head. All the other mountains, valleys, hills, woods, and villages, may be discerned from this spot. While with dismay and caution we crept upon our hands and knees to look over the brink of those fearful heights, a half-clad Tartar, wild as the winds of the north, mounted, without any saddle or bridle, except the twisted stem of a wild vine, on a colt equally unsubdued, galloped to the very edge of the precipice; and there, as his horse stood prancing upon the borders of eternity, amused himself in pointing to us the different places in the vast district which the eye commanded. We entered one of the excavated chambers; a small square apartment, leading to another on our right hand. On our left, a narrow passage conducted us to an open balcony with a parapet in front formed in the rock, upon the very face of one of the principal precipices, whence the depth below might be contemplated with less danger. Vultures beneath the view were sailing over the valleys, not seeming larger than swallows. Below these, the tops of undulating hills, covered by tufted woods, with villages amidst rocks and defiles, appeared at a depth so intimidating, that the blood chilled in beholding it. We afterwards found the remains of churches and other public buildings among the ruins, and in a more perfect state than might be expected in the Russian empire; but this is easily accounted for, by their difficulty of access. At length, being conducted to the north-eastern point

of the crescent, which is the shape of the summit on which the fortress of Mankoop was constructed, and descending a few stone steps, neatly hewn in the rock, we entered by a square door into a cavern, called by the Tartars *The Cape of the Winds*. It has been chisselled like the rest out of the solid stone; but it is open on four sides. From the amazing prospect here commanded of all the surrounding country, it probably served as a post of military observation. The apertures, or windows, are large arched chasms in the rock; through these, a most extensive range of scenery over distant mountains and rolling clouds forms a sublime spectacle. There is nothing in any part of Europe, to surpass the tremendous grandeur of the place. Below the cavern is another chamber leading to the several cells on its different sides; these have all been cut out of the same rock.

We pursued a different road in descending; passing beneath an old arched gateway of the citadel, once its principal entrance *. This road flanks the northern side of the mountain; and the fall into the valley is so bold and profound, that it seems, as if a single false step would precipitate both horse and rider. By alighting, the danger is avoided; and the terror of the descent compensated in the noblest scenery the eye ever beheld. It was dark before we reached the bottom; we had some difficulty to regain the principal road which leads through the defile, owing principally to the trees which project over all the lanes in the vicinity of Tartar villages, and so effectually obstruct the passage of persons on horseback, that we were in continual danger of being thrown; one of our party nearly lost an eye by a blow he received from a bough, which stretched quite across the path we pursued. The defile itself is not without danger in certain seasons of the year; immense masses of limestone detach themselves from the rocks above, carrying all before them in their passage. Some, from the northern precipices, had crossed the river at the bottom, and, by the prodigious velocity acquired in their descent, had actually rolled nearly half way up the opposite side. We passed some of those fragments in our way to Shulu, where we passed the night. This village belongs to Professor

* Future travellers who may visit Mankoop are advised to choose this road for their ascent; as it will afford them the sublimest scenery perhaps ever beheld. The Tartars, for what reason cannot be explained, call it the carriage-way, although we were unable to sit even upon our horses in going down.

Pallas, and consists of a forest of walnut-trees, beneath which every dwelling is concealed. One of those trees yielded him, as he informed us on the spot, in a single season, sixty thousand walnuts. The ordinary price of the fruit throughout the Crimea is from eighty to an hundred copeeks for a thousand *. The professor had built himself a very magnificent seat at Shulu, but owing to his disputes with the Tartars concerning the extent of his territory, the completion of the work had been delayed when we arrived. The building is placed on the northern side of the defile, commanding a fine prospect of the valley; but, from the chalky nature of the soil in the surrounding hills, every thing had a white glare, painful to the eye, and wholly destructive of picturesque appearance. Near this hill, on one of the eminences opposite to the professor's house, is a series of excavations similar to those of Inkerman: exhibiting the ancient retreats of Christians in cells and grottoes. One of those cavernous chambers is not less than eighty paces in length, with a proportionate breadth, and its roof is supported by pillars hewn in the rock; the stone, from the softness of its nature, did not oppose the difficulty encountered in similar works which are seen in other parts of the Crimea.

6. *Rock of Gibraltar.*

The mountain of Gibraltar is situated in 36° 9′ north latitude, and in 5° 17′ east longitude from Greenwich. It is the promontory of which, with that of Ceuta upon the opposite coast of Barbary, forms the entrance of the Straits of Gibraltar from the Mediterranean; and Europa Point, which is the part of the mountain that advances most towards Africa, is generally regarded as the most southern promontory in Europe. The form of this mountain is oblong; its summit a sharp craggy ridge; its direction is nearly from north to south; and its greatest length in that direction, falls very little short of three miles. Its breadth varies with the indentations of the shore, but it no where exceeds three quarters of a mile. The line of its ridge is undulated, and the two extremes are somewhat higher than its centre.

The summit of the Sugar Loaf, which is the point of its highest elevation towards the south, is 1439 feet; the Rock Mortar, which is the highest point to the north, is 1350; and the Signal House,

* The copeek is equal to our halfpenny.

which is nearly the central point between these two, is 1276 feet above the level of the sea. The western side of the mountain is a series of rugged slopes, interspersed with abrupt precipices. Its northern extremity is perfectly perpendicular, except towards the north west, where what are called the Lines intervene, and a narrow passage of flat ground that leads to the isthmus, and is entirely covered with fortification. The eastern side of the mountain mostly consists of a range of precipices; but a bank of sand, rising from the Mediterranean in a rapid acclivity, covers a third of its perpendicular height. Its southern extremity falls, in a rapid slope, from the summit of the Sugar Loaf, into a rocky flat, of considerable extent, called Windmill Hill. This flat forms half an oval, and is bounded by a range of precipices, at the southern base of which a second rocky flat takes place, similar in form and extent to Windmill Hill; and also, like it, surrounded by a precipice, the southern extremity of which is washed by the sea, and forms Europa Point. Upon the western side, this peninsular mountain is bounded by the bay of Gibraltar, which is in length nearly eight miles and a half, and in breadth upwards of five miles. In this bay the tide frequently rises four feet. Upon the north the mountain is attached to Spain by a low sandy isthmus, the greatest elevation of which, above the level of the sea, does not exceed 10 feet, and its breadth, at the base of the rock, is not more than three quarters of a mile. This isthmus separates the Mediterranean, on the east, from the bay of Gibraltar on the west.

This mountain is much more curious in its botanical, than in its mineralogical productions. In respect to the first, it connects, in some degree, the Flora of Africa with that of Europe. In respect to the latter, it produces little variety; perhaps a few substances and phænomena that are rare, but none that are peculiar.

The principal mass of the mountain rock consists of a grey, dense (what is generally called primary) marble; the different beds of which are to be examined in a face of 1350 feet of perpendicular height, which it presents to Spain in a conical form. These beds, or strata, are of various thickness, from 20 to upwards of 40 feet, dipping in a direction from east to west, nearly at an angle of 35 degrees. In some parts of the solid mass of this rock, I have found testaceous bodies entirely transmuted into the constituent matter of the rock, and their interior hollows filled up with calca-

reous spar; but these do not occur often in its composition, and its beds are not separated by any intermediate strata.

In all parts of the globe, where this species of rock constitutes large districts, it is found to be cavernous. The caves of Gibraltar are many, and some of them of great extent. That which most deserves attention and examination is called St. Michael's Cave, which is situated upon the southern part of the mountain, almost equally distant from the Signal Tower and the Sugar Loaf. Its entrance is 1000 feet above the level of the sea: This entrance is formed by a rapid slope of earth, which has fallen into it at various periods, and which leads to a spacious hall, incrusted with spar, and apparently supported in the centre by a large massy stalactical pillar. To this succeeds a long series of caves of difficult access. The passages from the one to the other of these are over precipices, which can only be passed by the assistance of ropes and scaling ladders. I have, myself, passed over many of these to the depth of 300 feet from the upper cave; but at that depth the smoke of our torches became so disagreeable, that we were obliged to give up our pursuit, and leave caves still under us unexamined. In these cavernous recesses, the formation and process of stalactites is to be traced, from the flimsy quilt-like cone, suspended from the roof, to the robust trunk of a pillar, three feet in diameter, which rises from the floor, and seems intended by nature to support the roof from which it originated.

The variety of form, which this matter takes in its different situations and directions, renders this subterraneous scenery strikingly grotesque, and in some places beautifully picturesque. The stalactites of these caves, when near the surface of the mountain, are of a brownish yellow colour; but, as we descended towards the lower caves, we found them begin to lose their darkness of colour, which by degrees shaded off to a whitish yellow.

The only inhabitants of these caves are bats, some of which are of a large size. The soil, in general, upon the mountain of Gibraltar, is but thinly sown; and in many parts that thin covering has been washed off by the heavy autumnal rains, which have left the superficies of the rock, for aconsiderable extent, bare and open to inspection. In those situations, an observing eye may trace the effects of the slow, but constant, decomposition of the rock, caused by its exposure to the air, and the corrosion of sea-salts, which, in the heavy gales

of easterly winds, are deposited with the spray on every part of the mountain. Those uncovered parts of the mountain rock also expose to the eye a phænomenon worthy of some attention, as it tends clearly to demonstrate, that, however high the surface of this rock may now be elevated above the level of the sea, it has once been the bed of agitated waters. This phænomenon is to be observed in many parts of the rock, and is constantly found in the beds of torrents. It consists of pot-like holes, of various sizes, hollowed out of the solid rock, and formed apparently by the attrition of gravel or pebbles, set in motion by the rapidity of rivers, or currents in the sea. One of those, which had been recently laid open, I examined with attention. I found it to be five feet deep, and three feet in diameter; the edge of its mouth rounded off as if by art, and its sides and bottom retaining a considerable degree of polish. From its mouth, for three and a half feet down, it was filled with a red argillaceous earth, thinly mixed with minute parts of transparent quartz crystals; the remaining foot and a half, to the bottom, contained an aggregate of water-worn stones, which were from the size of a goose's egg to that of a small walnut, and consisted of red jaspers, yellowish white flints, white quartz, and bluish white agates, firmly combined by a yellowish brown stalactitical calcareous spar. In this breccia I could not discover any fragment of the mountain rock, or any other calcareous matter, except the cement with which it was combined. This pot is 940 feet above the level of the sea.

Upon the west side of the mountain, towards its base, some strata occur, which are heterogeneous to the mountain rock: the first, or highest, forms the segment of a circle; its convex side is towards the mountain, and it slopes also in that direction. This stratum consists of a number of thin beds; the outward one, being the thinest, is in a state of decomposition, and is mouldering down into a blackish brown or ferruginous-coloured earth. The beds, inferior to this, progressively increase in breadth to 17 inches, where the stratification rests upon a rock of an argillaceous nature.

This last bed, which is 17 inches thick, consists of quartz of a blackish blue colour, in the septa or cracks of which are found fine quartz crystals, colourless, and perfectly transparent. These crystals are composed of eighteen planes, disposed in hexangular columns, terminated at both extremities by hexangular pyramids. The

largest of those that I have seen does not exceed two-eighths of an inch in length: They, in general, adhere to the rock by the sides of the column, but are detached without difficulty. Their great degree of transparency has obtained them the name of Gibraltar diamonds.

At no great distance from where these crystals are found, upon the same slope of the mountain, but rather nearer to the level of the sea, a stratum of argillaceous matter has been laid open, divided into many thin beds, the broadest of which does not exceed a foot in thickness. Its general colour is of a whitish grey, with a small mixture of yellow; and it is divided transversely by straight septa or cracks, both sides of which are covered with dendritical figures, of a yellowish brown colour, beautifully representing the objects of landscape. At the western base of the mountain, on a level with the sea by which it is washed, a very extensive stratum occurs, of the same nature as the last described, bearing from north to south, parallel with, and dipping towards, the mountain, nearly at an angle of 40 degrees.

In some parts of the western slope of the mountain, towards the south, are found nests of a dark red shivery clay, in which are embedded flints of a dirty sap green colour: Of those no regular stratum is to be perceived; many of them are unshapely masses; but they, in general, tend to the rhomboidal form, and are from three to four inches long, by two or three broad, and an inch and a half thick. They are not encrusted as the flints found in chalk, nor have they the appearance of having been worn by attrition.

Upon different parts of the mountain, towards its base, are found large quantities of sand, composed of different materials, and assuming various appearances as to colour. The largest bank of this arenaceous matter is upon the western side of the mountain, and consists of small particles of crystallized quartz, colourless, and perfectly transparent *per se*, but of an ochreous colour in the mass, on account of a red argillaceous earth which adheres to them. The sand of this bank is perfectly loose and uncombined: one half of it has been levelled into an extensive parade, its surface having been combined by the lime and rubbish from the ruins of the town. The southern extremity of the bank is still to be seen in its natural state, and forms the burying-ground of the garrison.

Upon the east side of the mountain is found another of these

banks, of considerable extent, and, as I mentioned before, rising from the Mediterranean in a rapid aclivity, and reaching to one-third of its entire elevation. This bank is composed of small particles of crystallized quartz, of testaceous bodies rounded by attrition, and of a few minute particles of the calcareous rock; the whole has a whitish grey colour. The rain-water, which falls from the bare mountain rock above the sand, brings along with it calcareous matter, which is deposited upon the bank, and combines its surface into a crust which in some places is so much indurated as to bear the pressure of the foot.

In other parts of the mountain, where this sand is surrounded by the calcareous rock, and covered in and protected from the action of the air, and corrosion of the sea-salts, it is found in a perfect indurated state, combined by stalactitical spar, and forming a minute breccia. A quarry of this arenaceous stone has been opened upon the south-east quarter of the mountain, and is made use of, with great propriety, to line the embrasures of some of the new works belonging to the garrison. Its inaptitude to fly off in splinters, when struck by a ball, gives, in such situations, additional safety to the defenders of the place.

The western side of the mountain's base, around Rosia Bay and the New Mole, is a rock composed of an aggregate of small fragments of every fossil that has been here described, with the addition of two different species of marble that are probably adventitious, as their native beds have not been found in the mountain. The one of those is black, and the other of an olive green colour. The whole of this mixture produces a most beautiful breccia, and is firmly combined by a calcareous cement of a yellow, verging towards an orange colour. It is susceptible of a high polish, except where fragments of the argillaceous strata occur: These can be easily smoothed down, but cannot be brought to a perfect polish. The fragments in this breccia are angular, and none of them have the appearance of being water-worn.

It only now remains for me to mention what are generally called the fossil bones, found in the rock of Gibraltar. These have been much talked of, and by some looked upon as a phænomenon beyond the power of explanation. The general idea which exists concerning them, is, that they are found in a petrified state, and inclosed

in the solid calcareous rock; but these are mistakes, which could only arise from inaccurate observation and false description.

In the perpendicular fissures of the rock, and in some of the caverns of the mountain, (all of which afford evident proofs of their former communication with the surface), a calcareous concretion is found, of a reddish brown ferruginous colour, with an earth fracture, and considerable induration, inclosing the bones of various animals, some of which have the appearance of being human*. These bones are of various sizes, and lie in all directions, intermixed with shells of snails, fragments of the calcareous rock, and particles of spar; all of which materials are still to be seen in their natural uncombined states, partially scattered over the surface of the mountain. These having been swept, by heavy rains at different periods, from the surface into the situations above described, and having remained for a long series of years in those places of rest, exposed to the permeating action of water, have become enveloped in, and cemented by, the calcareous matter which it deposits.

The bones, in this composition, have not the smallest appearance of being petrified; and if they have undergone any change, it is more like that of calcination than that of petrifaction, as the most solid parts of them generally admit of being cut and scraped down with the same ease as chalk.

Bones combined in such concretions are not peculiar to Gibraltar: they are found in such large quantities in the country of Dalmatia, and upon its coasts in the islands of Cherso and Osero, that some naturalists have been induced to go so far as to assert, that there has been a regular stratum of such matter in that country, and that its present broken and interrupted appearance has been caused by earthquakes, or other convulsions, experienced in that part of the globe. But, of late years, a traveller (Abbé Alberto Fortis), has given a minute description of the concretion in which the bones are found in that country: and by his account it appears, that with regard to situation, composition and colour, it is perfectly similar to

* These bones were not long since very generally conceived to be humane but Dr. Hunter, upon a minute examination of various specimens, demonstrated that they belong to some quadruped. We have already observed in chap. xxvii. that similar fossils are frequently to be met with in other rocks and caverns, especially in Dalmatia, and the gypsum quarries under the city of Paris.

that found at Gibraltar. By his description it also appears, that the two mountain rocks of Gibraltar and Dalmatia consist of the same species of calcareous stone; from which it is presumed, that the concretions in both have been formed in the same manner and about the same periods.

Perhaps if the fissures and caves of the rock of Dalmatia were still more minutely examined, their former communications with the surface might yet be traced, as in those described above; and, in that case, there would be at least a strong probability, that the materials of the concretions of that country have been brought together by the same accidental cause, which, in my opinion, has collected those found in the caverns of Gibraltar. I have traced, in Gibraltar, this concretion, from the lowest part of a deep perpendicular fissure, up to the surface of the mountain. As it approached to the surface, the concretion became less firmly combined, and, when it had no covering of the calcareous rock, a small degree of adhesion only remained, which was evidently produced by the argillaceous earth, in its composition, having been moistened by rain and baked by the sun.

The depth at which these materials have been penetrated by that proportion of stalactitical matter, capable of giving to the concretion its greatest adhesion and solidity, I found to vary according to its situation, and to the quantity of matter to be combined. In fissures, narrow and contracted, I found the concretion possessing a great degree of hardness at six feet from the surface; but in other situations more extended, and where a larger quantity of the materials had been accumulated, I found it had not gained its greatest degree of adhesion at double that depth. In one of the caves, where the mass of concretion is of considerable size, I perceived it to be divided into different beds, each bed being covered with a crust of the stalactical spar, from one inch to an inch and a half in thickness, which seems to indicate, that the materials have been carried in at various periods, and that those periods have been very remote from each other.

At Rosia Bay, upon the west side of Gibraltar, this concretion is found in what has evidently been a cavern, originally formed by huge unshapely masses of the rock, which have tumbled in together. The fissure, or cavern, formed by the disruption and subsidence of those masses, has been entirely filled up with the concretion, and is

now exposed to full view by the outward mass having dropped down, in consequence of the encroachments of the sea. It is to this spot that strangers are generally led to examine the phenomenon; and the composition, having he reattained to its greatest degree of hardness and solidity, the hasty observer, seeing the bones inclosed in what has so little the appearance of having been a vacuity, examines no further, but immediately adopts the idea of their being incased in the solid rock. The communication from this former chasm, to the surface from which it has received the materials of the concretion, is still to be traced in the face of the rock, but its opening is at present covered by the base of the line wall of the garrison. Here bones are found that are apparently human; and those of them that appear to be of the legs, arms, and vertebræ of the back, are scattered among others of various kinds and sizes, even down to the smallest bones of small birds. I found here the complete jaw-bone of a sheep; it contained its full complement of teeth, the enamel of which was perfect, and its whiteness and lustre in no degree impaired. In the hollow parts of some of the large bones was contained a minute crystallization of pure and colourless calcareous spar; but, in most, the interior part consisted of a sparry crust of a reddish colour, scarcely in any degree transparent.

At the northern extremity of the mountain, the concretion is generally found in perpendicular fissures. The miners there, employed upon the fortifications, in excavating one of those fissures, found, at a great depth from the surface, two skulls, which were supposed to be human; but, to me, one of them, if not both, appeared to be too small for the human species. The bone of each was perfectly firm and solid; from which it is to be presumed, that they were in a state of maturity before they were inclosed in the concretion. Had they appertained to very young children, perhaps the bone would have been more porous, and of a less firm texture. The probability is, that they belonged to a species of monkey, which still continues to inhabit, in considerable numbers, those parts of the rock which are to us inaccessible.

This concretion varies, in its composition, according to the situation in which it is found. At the extremity of Princes Lines, high in the rock which looks towards Spain, it is found to consist only of a reddish calcareous earth, and the bones of small birds cemented thereby. The rock around this spot is inhabited by a number of

hawks, that in the breeding season nestle here, and rear their young; the bones in this concretion are probably the remains of the food of those birds. At the base of the rock, below King's Lines, the concretion consists of pebbles of the prevailing calcareous rock. In this concretion, at a very considerable depth under the surface, was found the under parts of a glass bottle, uncommonly shaped, and of great thickness; the colour of the glass was of a dark green.

In many parts of the rocks I have found concretions, in which there are no bones of any kind; and on the elevated parts of the mountain, where the slopes are rapid, I have found a breccia (if I may so call it), entirely consisting of snail-shells, combined in a mass of opaque stalactitical spar of a yellowish brown colour. The various progressive augmentations of this matter were to be traced in various shades of the same colour, which, like the zones of the antique alabaster, curve round, and follow the form of the shell. The purer matter of this spar has penetrated the shells, and in their interior hollows has formed a lining of small crystals, generally colourless and perfectly transparent.

I have bestowed more time in endeavouring to describe the composition, and the real situation of this concretion of bones, than the subject, in the estimation of many, will seem to deserve, and indeed more than it deserves in my own opinion; but where an erroneous opinion has obtained a footing, in consequence of inaccurate observations and partial description, it is the duty of every new observer to endeavour to correct it.

[*Edinb. Phil. Trans.*]

SECTION VIII.

Basaltine Columns and Causeways.

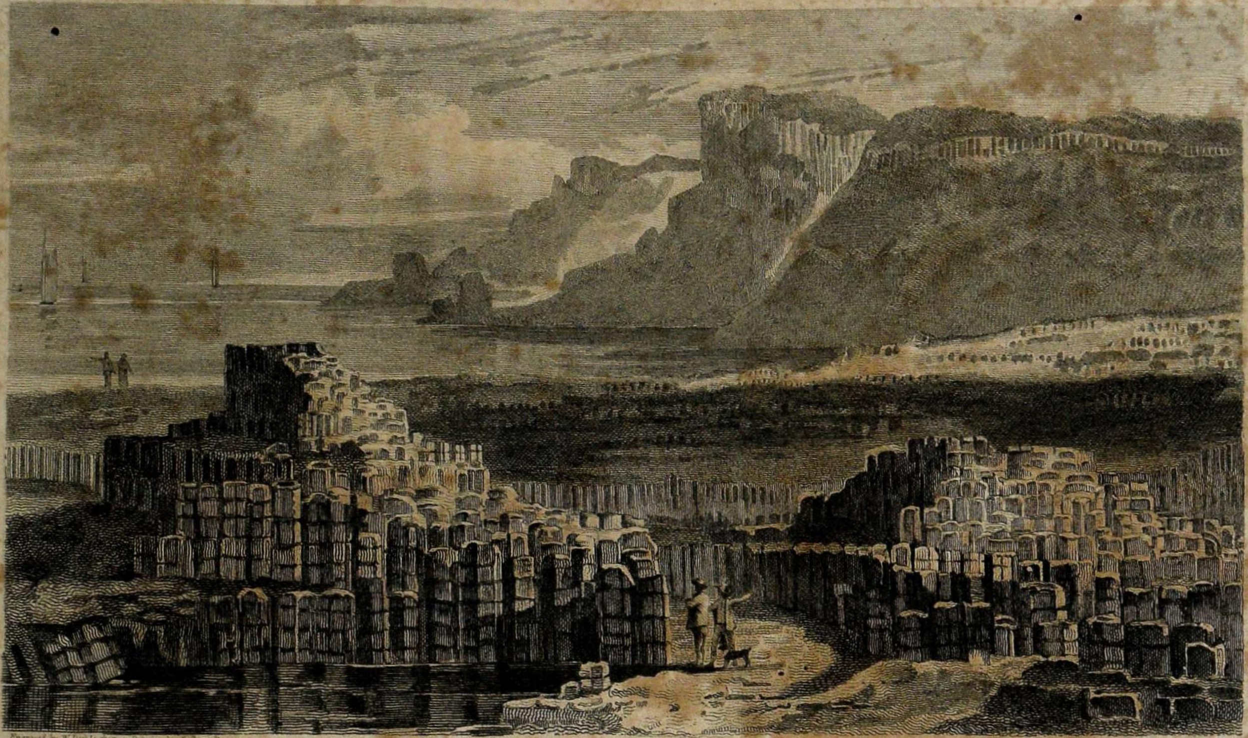
AMONG the more extraordinary curiosities of mineralogy may be enumerated a kind of stone or slimy crystallization of a very fine texture, and of a deep glossy black colour, resembling that of polished steel, and rarely intermixed with any extraneous matter of any kind. The most remarkable quality of this stone is its figure, being never found in strata, but standing up in the form of regular angular columns, composed of a number of joints placed upon and nicely fitted to each other, as if formed by the hands of a skilful

workman. It is remarkably hard and heavy, will not strike fire with steel, and is a fine touchstone.

This stony crystallization is called *basalt* or *basáltes*. It was earliest discovered in columns in Ethiopia, and in fragments in the river Tmolus. We now meet with it frequently both in columns and small pieces in Spain, Russia, Poland, Silesia, Italy; and especially in our own country, as at the harbour at Dunbar, in the island of Staffa, which has already passed beneath our survey, and in the county of Antrim in Ireland, where it constitutes the most magnificent scenery of the kind in the world, and is known under the name of the *Giant's Causeway*.

The term GIANT'S CAUSEWAY appears to have been applied to this stupendous work, from an idea indulged in dark and ignorant times, that it is an artificial production, the vast labour of giants that formerly inhabited the country; a little attention, however, to the following description will abundantly prove that this and every similar mineralogical mass is the work of nature alone, and that art neither has nor could have been the cause of them.

The principal or grand causeway (for there are several less considerable and scattered fragments) consists of a most irregular arrangement of many hundred thousands of columns: almost all of them are of a pentagonal figure, but so closely and compactly situated on their sides, though perfectly distinct from top to bottom, that scarcely any thing can be introduced between them. The columns are of an unequal height and breadth: some of the highest, visible above the surface of the strand, and at the foot of the impending angular precipice, perhaps about 20 feet, they do not exceed this height, at least none of the principal arrangement. How deep they are fixed in the strand was never yet discovered. This grand arrangement extends nearly 200 yards, visible at low water; how far beyond is uncertain: from its declining appearance, however, at low water, it is probable it does not extend under water to a distance any thing equal to what is seen above. The breadth of the principal causeway which runs out in one continued range of columns, is, in general, from 20 to 30 feet; at one place or two it may be nearly 40 for a few yards. In this account are excluded the broken and scattered pieces of the same kind of construction, that are detached from the sides of the grand causeway, as they do not appear to have ever been contiguous to the principal arrange-



Engraved by W. Deeble from a Drawing by L. Dennell. — for the Gallery of Nature & Art.

GIANT's CAUSEWAY, ON THE COAST OF ANTRIM, IRELAND.

London, Published by R. Wilks, 89, Chancery Lane, April 1, 181[illegible].

ment, though they have frequently been taken into the width; which has been the cause of such wild and dissimilar representations of this causeway, which different accounts have exhibited. The highest part of this causeway is the narrowest, at the very spot of the impending cliff whence the whole projects, where, for four or five yards, it is not above ten or fifteen wide. The columns of this narrow part incline from a perpendicular a little to the westward, and form a slope on their tops, by the unequal height of the columns on the two sides; by which an ascent is made at the foot of the cliff, from the head of one column to the next above, gradatim, to the top of the great causeway, which, at the distance of half a dozen yards from the cliff, obtains a perpendicular position, and, lowering in its general height, widens to about 20 or between 20 and 30 feet, and for 100 yards nearly is always above water. The tops of the columns for this length being nearly of an equal height, they form a grand and singular parade that may be easily walked on, rather inclining to the water's edge. But from high water mark, as it is perpetually washed by the beating surges on every return of the tide, the platform lowers considerably, and becomes more and more uneven, so as not to be walked on but with the greatest care. At the distance of 150 yards from the cliff, it turns a little to the east for 20 or 30 yards, and then sinks into the sea. The figure of these columns is almost unexceptionably pentagonal, or composed of five sides; there are but very few of any other figure introduced: some few there are of three, four, and six sides, but the generality of them are five-sided, and the spectator must look very nicely to find any of a different construction; yet what is very extraordinary, and particularly curious, there are not two columns in ten thousand to be found, that either have their sides equal among themselves, or whose figures are alike.

Nor is the composition of these columns or pillars less deserving the attention of the curious spectator. They are not of one solid stone in an upright position, but composed of several short lengths, curiously joined, not with flat surfaces, but articulated into each other like a ball and socket, or like the joints in the vertebræ of some of the larger kind of fish, the one end at the joint having a cavity into which the convex end of the opposite is exactly fitted. This is not visible but by disjoining the two stones. The depth of the concavity or convexity is generally about two or three inches. And what

is still farther remarkable of the joint, the convexity, and the correspondent concavity, are not conformed to the external angular figure of the column, but exactly round, and as large as the size or diameter of the column will admit; and consequently as the angles of these columns are in general extremely unequal, the circular edges of the joint are seldom coincident with more than two or three sides of the pentagonal, and from the edge of the circular part of the joint to the exterior sides and angles they are quite plain. It is still farther very remarkable likewise, that the articulations of these joints are frequently inverted; in some the concavity is upwards, in others the reverse. This occasions that variety and mixture of concavities and convexities on the tops of the columns, which is observable throughout the platform of this causeway, yet without any discoverable design or regularity with respect to the number of either. The length also of these particular stones, from joint to joint, is various; in general they are from 18 to 24 inches long; and, for the most part, longer towards the bottom of the columns than nearer the top, and the articulation of the joints something deeper. The size or diameter likewise of the columns is as different as their length and figure; in general they are from 15 to 20 inches in diameter. There are no traces of uniformity or design discovered throughout the whole combination, except in the form of the joint, which is invariably by an articulation of the convex into the concave of the piece next above or below it; nor are there any traces of a finishing in any part, either in height, length, or breadth, of this curious causeway. If there is here and there a smooth top to any of the columns above water, there are others just by, of equal height, that are more or less convex or concave, which show them to have been joined to pieces that have been washed, or by other means taken off. And undoubtedly those parts that are always above water have, from time to time, been made as even as might be; and the remaining surfaces of the joints must naturally have been worn smoother by the constant friction of weather and walking, than where the sea, at every tide, is beating upon it, and continually removing some of the upper stones, and exposing fresh joints. And farther, as these columns preserve their diameters from top to bottom, in all the exterior ones, which have two or three sides exposed to view, the same may with reason be inferred of the interior columns whose tops only are visible.

Yet, what is very extraordinary and equally curious in this phenomenon is, that notwithstanding the universal dissimilitude of the columns, both as to their figure and diameter, and though perfectly distinct from top to bottom, yet is the whole arrangement so closely combined at all points, that hardly a knife can be introduced between them either upon the sides or angles. And it is no small entertainment to examine the close contexture and nice insertion of such an infinite variety of angular figures as are exhibited on the surface of this grand parade. From the infinite dissimilarity of the figure of these columns, this will appear a most surprising circumstance to the curious spectator; and would incline him to believe it a work of human art, was it not, on the other hand, inconceivable that the genius or invention of man should construct and combine such an infinite number of columns, which should have a general apparent likeness, and yet be so universally dissimilar in their figure, as that, from the minutest examination, not two in ten or twenty thousand should be found whose angle sand sides are equal among themselves, or of the one column to those of the other. That it is the work of nature there can be no doubt to an attentive spectator, who carefully surveys the general form and situation, with the infinitely various configuration of the several parts of this causeway. There are no traces of regularity or design in the outlines of this curious phenomenon; which, including the broken and detached pieces of the same kind of workmanship, are extremely scattered and confused; and, whatever they might be originally, do not at present appear to have any connection with the grand or principal causeway, as to any supposable design or use in its first construction, and as little design can be inferred from the figure or situation of the several constituent parts. The whole exhibition is, indeed, extremely confused, ununiform, and destitute of every appearance of use or design in its original construction. But what, beyond dispute, determines its original to have been from nature is, that the very cliffs, at a great distance from the causeway, especially in the bay to the eastward, exhibit at many places the same kind of columns, figured and jointed in all respects like those of the grand causeway; some of them are seen near to the top of the cliff, which, in general, in these bays to the east and west of side the causeway, is near 300 feet in height; others again are seen about midway, and at different elevations from the strand. A very considerable exposure of them is seen in the very bottom of the bay to

the eastward, near 100 roods from the causeway, where the earth has evidently fallen away from them upon the strand, and exhibits a most curious arrangemen t of many of tese pentagonal columns, in a perpendicular position, supporting, in appearance, a cliff of different strata of earth, clay, rock, &c. to the height of 150 feet or more, above. Some of these columns are between 30 and 40 feet high, from the top of the sloping bank below them; and being longest in the middle of the arrangement, shortening on either hand in view, they have obtained the appellation of organs, from a rude likeness in this particular to the exterior or frontal tubes of that instrument; and as there are few broken pieces on the strand near it, it is probable that the outside range of columns that now appears is really the original exterior line, toward the sea, of this collection. But how far they extend internally into the bowels of the incumbent cliff is unknown. The very substance, indeed, of that part of the cliff which projects to a point, between the two bays on the east, and west of the causeway, seems composed of this kind of materials; for, besides the many pieces that are seen on the sides of the cliff that circulate to the bottom of the bays, particularly the eastern side, there is, at the very point of the cliff, and just above the narrow and highest part of the causeway, a long collection of them seen, whose heads or tops just appearing without the sloping bank, plainly show them to be in an oblique position, and about half-way between the perpendicular and horizontal. The heads of these, likewise, are of mixed surfaces, convex and concave, and the columns evidently appear to have been removed from their original upright, to their present inclining or oblique position, by the sinking or falling of the cliff.

Giant's Causeways, or basaltic columns of a similar kind, though less magnificent in appearance, are common to the country about Padua. Mr. Strange, who resided for many years as British consul at Venice, has given an account of several of them in different articles in the Philosophical Transactions, particularly one situated at Castel Nuovo, a small village near Teolo in the Euganean hills; and another at Monte Rosso, at no great distance. The last communication is well worth noticing, as it takes a general survey of this singular phenomenon, and compares its most striking characters with each other as they appear in different parts of the world. Mr. Strange first gives a topographical view of a part of the

south-east side of a hill, called Monte Rosso, about seven miles nearly south of Padua, in the Venetian State in Italy, and a mile to the west of Abano, a village well known, from the celebrated hot baths of that name, and which are situated at half a mile distance to the south of it. This view particularly represents a natural range of prismatic columns, of different shapes and sizes, placed in a direction nearly perpendicular to the horizon, and parallel to each other, much resembling that part of the famous Giant's Causeway in Ireland, called The Organs. The next is a similar representation of the west side of another basaltine hill, called Il Monte del Diavolo, or the Devil's Hill, near San Giovanni Illarione, also in the Venetian State, and Veronese district, about ten miles nearly north-west of Vicenza. The prismatic columns appear to be ranged in an oblique position, along the side of the hill. This drawing, however, represents only a part of the Causeway of San Giovanni, which continues along the side of a valley, nearly in the same manner, to a considerable distance. Though the columns of both these hills are of the simple, or unjointed species, yet they differ very remarkably from each other in many respects, but principally in their forms, and the texture and quality of their parts. Those of San Giovanni commonly approach a circular form, as nearly as their angles will permit; which is also observable in the columns of the Giant's Causeway, and of most other basaltine groups. On the contrary, those of Monte Rosso rather affect an oblong or oval figure. The columns of San Giovanni measure, one with the other, near a foot in diameter: nor do they vary much in their size; though this is often the case in similar groups, and is particularly observable in that of Monte Rosso, whose columns sometimes equal nearly a foot in diameter, while others scarcely exceed three inches; their common width is about six or eight inches. They differ, therefore, very considerably in size from those of the Giant's Causeway; some of which, it is well known, measure two feet in width. Nothing certain can be said concerning the length of the columns of San Giovanni, as they present only their tops to view; the remaining parts of them being deeply buried in the hill, and in some places entirely covered. The columns of Monte Rosso, as far as they are visible, measure only from six to eight or ten feet in height, which is also a small size, when compared with the height of those of the Giant's Causeway, some of which measure near forty feet. The columns of

the Venetian groups manifest however all the varieties of prismatic forms, that are observable in those of the Giant's Causeway, and other similar groups. But they are commonly either of five, six, or seven sides; but the hexagonal form seems mostly to prevail, which is also remarkable in the Giant's Causeway, and probably in most others.

Nor is there less difference in the texture and qualities of these columns, than in their forms. Those of San Giovanni present a smooth surface, and, when broken, appear within of a dark iron grey colour, manifesting also a very solid and uniform texture; in which characters they correspond with the columns of the Giant's Causeway, and those of most other basaltine groups. But the columns of Monte Rosso are very different in all these respects. For they have not only a very rough, and sometimes knotty surface, but, when broken, show a variegated colour and unequal texture of parts. They are commonly speckled, as it were more or less distinctly, and resemble an inferior sort of granite, of which Monte Rosso itself is formed, and which serves as a base to the range of columns in question. It is, in general, not quite so hard as the Alpine and Oriental granites, and is sometimes even friable. Linnéus justly observes, that this species of granite abounds in France; for I have lately seen large tracts of it in the neighbouring provinces of Auvergne, Velay, and Lionnois; and apprehend, that it likewise abounds in the Vivarey, Gevaudan, and Cevennes mountains; from the affinity observable in the physical geography of those countries. But it is equally common in Italy; for besides Monte Rosso, the bulk of the Euganean hills in general, of which that is a part, principally consists of it; and these hills occupy a considerable tract in the plains of Lombardy. It is also common in the Tuscan and Roman states; the mountain close to the Viterbo, on the road to Rome, is entirely composed of it. The columns of Monte Rosso appear therefore of a different character from any hitherto described by mineralogists, who only mention those of a uniform colour and texture. But the great singularity here is, that such a range of prismatic columns should be found bedded, as it were in a mass of granite, and composed nearly of the same substance; of which I never yet saw or heard any other instance, This circumstance seems therefore to render the causeway of Monte Rosso more curious and singular than the famous one in Ireland is known to be, from the regular articulation of its columns; the same phenomenon having lately been discovered at

Staffa, one of the western islands of Scotland. Different groups of articulated basaltine columns have likewise been observed in the province of Auvergne in France; particularly by M. Beost de Varennes, at Blaud near Langeac; and by M. Desmarests, near Mont d'Or. M. Sage also mentions another near St. Alcon, in the same province. The Monte Rosso group is, however, not only curious in itself, but very interesting, on account of the great light it seems to throw on the origin of granites in general.

It is remarkable, that the columns in the two different groups of Monte Rosso and San Giovanni, preserve respectively the same position, nearly parallel to each other; which is not commonly the case in other basaltine groups. For though the principal aggregate, which forms the Giant's Causeway, stands in a direction perpendicular to the horizon; yet other small detached groups of columns also appear in the hill above, that affect by their position different degrees of obliquity. Among the numerous basaltine hills of Auvergne and Velay, in France, which seem to abound in those provinces more than in any other part of Europe, and perhaps of the known globe, nothing is more common than to see the columns of the same group lying in all possible directions, as irregularly almost as the prisms in a mass of common crystal. Nor is this variety of position so observable in single columns, as in whole masses or ranges of them, which often present themselves in the same hill, disposed in different strata or stages, as it were, one above the other, many of which affect very different, and even opposite directions. The columns of San Giovanni seem bedded in a kind of vulcanic sand, which, in many parts of the hill, entirely covers them; these however probably rest at bottom on a base of basaltine rock of the same nature. Nothing is more common in the provinces of France just mentioned, than to see isolated basaltine hills almost exclusively composed of different layers of columns, which present themselves in stages, one above the other, often without any other stratum between them, resembling, in some measure, *si magna licet componere parvis*, a huge pile or stack of cleft wood. Though the columnar crystallization of Monte Rosso is the only one perhaps yet seen, or heard of, in a mass of granite, yet other groups of columns have occurred to me in other parts, that are equally of a heterogeneous subtance or texture, though different from those of Monte Rosso, as well as from the common basalts.

Systematic mineralogists, in general, assign the same common origin to most lapideous solids, which they suppose to be generated by deposition from an aqueous fluid. In whatever manner therefore the prismatic bodies in question are classed, on such a principle, no adequate idea can thence be ascertained concerning their origin, which seems manifestly different. For surely the structure, and other phænomena of these bodies, sufficiently prove them to be crystallizations or concretions of a particular kind, and generated immediately from an igneous fluid: for they are not only peculiar to vulcanic tracts of country; but differ, in every respect, from common crystals produced from an aqueous fluid. Every one knows, that the latter are formed stratum super stratum, by a slow and successive deposition and juxta-position of parts, as hath been proved satisfactorily by Cappeler, Linnéus, and other writers on this subject. The same mode of generation is more particularly explained by Steno, in his excellent treatise, De Solido intra Solidum naturaliter Contento. But this mode does not seem at all reconcileable with the basaltine crystallizations in question. For however these bodies may vary in their texture, yet none of them afford the least indication of an origin common to other crystals; but seem rather the effects of some intrinsic principle of organization, by which they appear to have been produced simultaneously, in a manner, on the consolidation of the whole mass of matter, in which they lie, and with which they constantly bear the greatest analogy, as before observed. It is further remarkable, that common crystals are parasitical bodies; whereas basaltine crystallizations, notwithstanding the peculiarities of their figures, rather seem to form integral parts of the masses to which they adhere; and seem to acknowledge, with them, one common and simultaneous origin; like the rhomboidal and other crystallizations in granites, and other similar vitrifiable compound stones. The common slow and limited principle of crystallization, seems not at all adequate to so great an effect, which seems exclusively attributable to an igneous fluid, on the general concretion of which, the organic principle may be supposed to have operated simultaneously in a large mass, and produced these bodies in the same manner as a linget of metal concretes at once in the mould. No other mode of generation seems reconcileable with the phænomena of basaltine aggregates. It seems also further evident from the phænomena, that prismatic basaltine crystallizations, and

other regularly figured vulcanic groups, have been generated locally, and not in the midst of those violent convulsions of Nature which are commonly assigned for the origin of vulcanic mountains in general. That the principle of organization, whatever it be, operates locally in the formation of these bodies, appears sufficiently evident from the regular disposition and other particular characters of their groups. For notwithstanding the various directions of the columns, and masses composed of them, in the different groups, yet in other respects the greatest regularity of disposition is commonly observable. They form strata, which are uniformly organized, disposed in particular directions, and often constant in the same to a great extent. These strata not only manifest a parallelism between their regularly figured parts, but in their whole aggregates; which often form extensive horizontal beds, and of an equal thickness throughout. This parallelism is also equally remarkable in groups that are composed of many strata; as I have particularly observed in those of Murat, and the Castle Hill of Achon, in Upper Auvergne; in which the columnar strata are not only parallel in themselves, but preserve in their position, a parallelism with the other strata of the respective groups, which lie in regular stages, one above the other; and since these groups commonly form, in a manner, integral parts of the masses, or mountains in which they are found, and these manifest also some affinity in their structure; it seems most reasonable to assign to both one common origin.

The Euganean hills form an irregular group in the plain of Lombardy, about 7 miles nearly south by west from Padua, and extend from north to south as far as Este. The most considerable part of them composes an irregular sort of chain, which extends in the above direction; while other parts are severally detached, and form isolated mountains about the skirts of this chain, particularly on the north east side, towards Albano. The outer skirt of the entire group may measure from thirty to forty English miles. The external characters of this group exactly correspond with the forms commonly ascribed by naturalists to vulcanic mountains in general; since the points of the chain beforementioned, as well as the isolated members of it, are of various conical, orbicular, and elliptical shapes. As this group, therefore, rests on a perfect plain, it makes a very singular appearance. The vulcanic hills immediately round Isenchaux in Velay affect also the same forms; but as they are mixed with other hills of a

different form, and the country about them is broken and irregular, they do not produce so singular an effect as the Euganean hills, which suddenly rise from a perfect level. I am informed, that there is a similar, though smaller group of isolated vulcanic hills in a plain of Dalmatia, near Cossova; and another group of hills, nearly of the same forms, in the county of Down, in Ireland, and called the Mourn hills, which, like those near Padua, consist mostly of granite and lava. The Euganean hills have, moreover, a superficial and partial covering of slaty and calcareous strata, of posterior origin, and that manifest no marks of having suffered by fire. Such strata slightly cap Mount Venda, which is the highest among these hills; though of no very considerable elevation, measuring only about 252 French toises above the Venetian Lagunes, according to Abbé Toaldo, professor of astronomy at Padua. From the lava and granite mixed together in the Euganean hills, they bear an affinity with those of Auvergne and Velay; but differ from them by the superincumbent unburnt strata of lime-stone.

[*Beost de Varennes. Linnéus. Sage. Phil. Trans.*]

SECTION IX.

Wide and inhospitable Deserts.

In taking a general survey of the earth's solid surface, the extraordinary phænomena of its *deserts* ought by no means to be passed by without notice, as they constitute in two of its chief divisions features peculiarly prominent, and in one of them present to us its most striking character.

It is to these two quarters, however, that we shall confine our attention; for though extensive ranges of red sand, and sandstone rock, are occasionally to be met with in other divisions of the globe, they are not of importance enough to require notice in such a work as the present.

The chief Asiatic Deserts are to be met with in Persia and Arabia.

Persia enfolds three deserts of considerable extent and celebrity. The first commences on the east of the Tigris in lat. 33, is pervaded by the river Ahwaz, and extends to the north of Shuster. The second reaches from the vicinity of Korn very nearly to the Zurra, in a line from east to west of about 400 English miles, and from north

to south of about 250: but as in the latter quarter it joins the great desert of Kerman, which alone extends over a track of not less than 350 miles, these may be contemplated as forming one common desert; and as stretching north-west and south-east over a space of about 700 miles (without including the desert of Mekran of about 200 miles in length, which lies also in the vicinity), and thus intersecting this wide empire into two nearly equal portions. This vast extent is impregnated with nitre and other salts, which taint the neighbouring lakes and rivers, on which account it has been denominated *The Great Saline Desert:* but its natural history has not been very precisely investigated.

The third great Persian desert we have referred to is denominated that of Karahum, or the Black Sand, and forms the northern boundary of Corasan and northern Persia.

The sandy DESERTS OF ARABIA form one of the most striking objects of the country. From the hills of Omon, which seem a continuation of those on the other side of the Persian gulph, as far on as Mecca, the greater part of Neged is one prodigious desert, interrupted towards the frontiers of Hejaz and Yeman, or Happy Arabia, by Kirgé, containing the district of Sursa, and several *oases* or fertile spots, as well as towns, laid down by Niebuhr. The north-west part of Neged presents almost a continued desert, probably a prolongation of the preceding, with an oasis called Ared, on the west of Lasa, including Jabrin, and a few other places. In this desert we also know of the oasis of Mount Schamer, and it is probable there are various others unknown to European geographers.

Of AFRICA we have already observed, that its most striking feature consists in the immense deserts that pervade its face, and which may perhaps comprise one half of its whole extent. Of these the chief is called *Sahara*, or *The Desert*, by way of eminence. It stretches from the shores of the Atlantic, with few interruptions, to the confines of Egypt, a space of more than forty-five degrees, or about 2500 German miles, by a breadth of twelve degrees, or 720 German miles. It is one prodigious expanse of red sand, and sand-stone rock, of the granulations of which the red sand consists. It is in truth an empire of sand that defies every exertion of human power or industry; though it is interspersed with various islands or fertile and cultivated spots of different sizes, of which Fezzan is one of the chief that has hitherto been explored.

Nearly in the centre of this sandy ocean, and nearly half way between the Mediterranean and the Guinea coast, rise the walls of Timbuctoo, or Tombuctoo, the capital of the very extraordinary Black empire of Bembarra, the monarch of which is a negro, the court and army of which are negroes, and the great part of whose population are negroes—a city which constitutes the great mart for the commerce of all the interior of Africa, and where trade and merchandise are protected and encouraged, and have been protected and encouraged for many ages. To maintain this commerce is the laborious work of caravans which cross this enormous desert from almost every part of the African coast; and the mode in which it is thus traversed is too curious to be overlooked upon the present occasion. We shall take the description from Mr. Jackson, the latest and apparently the best informed of our African travellers.

Timbuctoo, says he, the great emporium of central Africa, has from time immemorial carried on a very extensive and lucrative trade with the various maritime states of North Africa, viz. Morocco, Tunis, Algier, Tripoli, Egypt, &c. by means of (akkabaahs) accumulated caravans, which cross the great desert of Sahara, generally between the months of September and April inclusive; these akkabaahs consist of several hundred loaded camels, accompanied by the Arabs who let them to the merchants, for transport of their merchandize to Fez, Morocco, &c. at a very low rate. During their route, they are often exposed to the attacks of the roving Arabs of Sahara, who generally commit their depredations as they approach the confines of the desert.

In this tiresome journey, the akkabaahs do not proceed in a direct line across the trackless desert to the place of their destination, but turn occasionally eastward or westward, according to the situation of certain fertile, inhabited, and cultivated spots, interspersed in various parts of Sahara, like islands in the ocean, called oas, or oases; these serve as watering-places to the men, as well as to feed, refresh, and replenish the hardy and patient camel: at each of these oases, the akkabaah sojourns about seven days, and then proceeds on its journey, until it reaches another spot of the same description. In the intermediate journies, the hot winds, denominated shume*, or

* Asshume, or Shume; during the prevalence of this wind it is impossible to live in the upper rooms of the houses, the inhabitants, therefore, retire to subterraneous apartments, cellars, or warehouses on the ground floor, eating

simoom, are often so violent, as considerably, if not entirely, to exhale water carried in skins by the camels for the use of the passengers and drivers; on these occasions the Arabs and people of Soudan affirm that 500 dollars have been given for a draft of water, and that 10 or 20 are commonly given when a partial exhalation has occurred.

In 1805, a caravan proceeding from Timbuctoo, to Tafilet, was disappointed in not finding water at one of the usual watering-places, when, horrible to relate, the whole of the persons belonging to it, 2000 in number, besides 1800 camels, perished of thirst! Accidents of this sort, account for the vast quantities of human and other bones which are found mingled together in various parts of the desert.

The intense heat of the sun, aided by the vehement and parching wind driving the loose sand along the boundless plains, gives to the

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nothing but fruits, as the water melon, and the prickly pear, for animal food at this period is loathsome whilst hot, and has scarcely time to cool before it becomes tainted. The walls of the bed-chambers being of stone, buckets of water are thrown against them to render the rooms habitable towards night; and so great is their heat, that in doing this, the effect is similar to what is produced by casting water on hot iron. I have felt the shume twenty leagues out at sea; when in lat. north 30°, longitude west 11° 30′, I astonished the captain of the ship, by directing his attention to particles of sand which fell on the deck; and although the mariners actually collected about a wine glass full of this sand by sweeping the deck, yet he would scarcely credit my assertion, until we reached Agadeer, when he met with many daily proofs of the extraordinary effects of this tremendous wind. I never found any extreme inconvenience from the shume north of the province of Suse, although at Mogador it is sometimes felt, but not so severely, during three days.

The akkabaahs are sometimes obliged suddenly to strike their tents, and proceed on their journey, from the shume arising, and drifting the loose sand along the plains, which attaches to every fixed object in its course, and soon buries it. Savary, who often sacrifices truth to the pomp of language, has committed a gross error in describing the desert; he says—"Woe to him, whom a whirlwind from the south surprises in the midst of the solitude, if he have not a tent to shelter him; he is assailed by clouds of burning dust which fills his eyes, ears, and mouth, and deprives him of the faculty of sight and breathing." (See Letters on Egypt.) Now, so far from tents being any permanent protection during these winds, they are rather an annoyance, for it is impossible to keep them upright; and, if they are not immediately struck, they, and all within them, are soon buried in the overwhelming torrents of sand.

See for this and similar winds, Vol. III. Chap. xl. Sect. iv. of the present work.—EDITOR.

desert the appearance of a sea, the drifting sands resembling exactly the waves of the ocean, and hence aptly denominated by the Arabs (el bahar billa mâa) a sea without water.

It is generally affirmed, that the guides, to whom the charge of conducting these numerous and accumulated caravans is committed, in their routes to and from Morocco, direct their course by the scent of the sandy earth; but I could never discover any reasonable foundation for such an opinion, and apprehend it to be an artful invention of their own, to impose on the credulity of this superstitious and ignorant people, and thus to enhance the value of their knowledge. These guides possess some idea of astrology, and the situation of certain stars, and being enabled by the two pointers to ascertain the polar star, they can by that unvarying guide steer their course with considerable precision, preferring often travelling in the night, rather than under the suffocating heat of the scorching meridian sun.

When the akkabaah reaches Akka, the first station on this side of the desert, and situated on the confines thereof, in Lower Suse, which is a part of Bled-el-jerrêde, the camels and guides are discharged, and others there hired to proceed to Fez, Morocco, Terodant, Tafilelt, and other places.

The akkabaahs perform the traverse of the desert, including their sojournments at El-wahs, or Oases, in about 130 days. Proceeding from the city of Fez, they go at the rate of 3½ miles an hour, and travel 7 hours a day; they reach Wedinoon, Tatta, or Akka in 18 days, where they remain a month, as the grand accumulated akkabaah proceeds from the latter place.

In going from Akka to Tagassa, they employ sixteen days, here sojourning fifteen days more to replenish their camels; they then proceed to the oasis and well of Taudeny, which they reach in seven days; here again they remain fifteen days; their next route is to Arawan, another watering-place, which they reach in seven days; here they sojourn fifteen days; and then proceed and reach Timbuctoo the sixth day, making a journey of fifty-four days actual travelling, and of seventy-five days repose, being altogether, from Fas to Timbuctoo, one hundred and twenty-nine days, or four lunar months and nine days*.

There is another akkabaah which sets out from Wedinoon and

* Some akkabaahs perform the journey in less, I myself having, when I had a commercial establishment at Agadeer, received a caravan of gum Soudan from Timbuctoo in eighty-two days.